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Warm mid-Cretaceous high-latitude sea-surface temperatures from the southern Tethys Ocean and cool high-latitude sea-surface temperatures from the Arctic Ocean: asymmetric worldwide distribution of dinoflagellates

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Dealing with 87 articles and using a Geographical Information System, Masure and Vrielynck (2009) have mapped worldwide biogeography of 38 Late Albian dinoflagellate cysts and have demonstrated Cretaceous oceanic bioclimatic belts. For comparison 30 Aptian species derived from 49 studies (Masure et al., 2013) and 49 Cenomanian species recorded from 33 articles have been encountered. Tropical, Subtropical, Boreal, Austral, bipolar and cosmopolitan species have been identified and Cretaceous dinoflagellate biomes are introduced. Asymmetric distribution of Aptian and Late Albian/Cenomanian subtropical Tethyan species, from 40°N to 70°S, demonstrates asymmetric Aptian and Late Albian/Cenomanian Sea Surface Temperature (SST) gradients with warm water masses in high latitudes of Southern Ocean. The SST gradients were stronger in the Northern Hemisphere than in the Southern Hemisphere. We note that Aptian and Late Albian/Cenomanian dinoflagellates restricted to subtropical and subpolar latitudes met and mixed at 35-40°N, while they mixed from 30°S to 70°S and from 50°S to 70°S respectively in the Southern Hemisphere. Mixing belts extend on 5° in the Northern Hemisphere and along 40° (Aptian) and 20° (Late Albian/Cenomanian) in the Southern one. The board southern mixing belt of Tethyan and Austral dinoflagellates suggest co-occurrence of warm and cold currents. We record climatic changes such as the Early Aptian cooler period and Late Aptian and Albian warming through the poleward migration of species constrained to cool water masses. These species sensitive to temperature migrated from 35°N to 55°N through the shallow Greenland-Norwergian Seaway connecting the Central Atlantic and the Arctic Ocean. While Tethyan species did not migrate staying at 40°N. We suggest that the Greenland-Norwergian Seaway might has been a barrier until Late Albian/Cenomanian for oceanic Tethyan dinoflagellates stopped either by the shallow water column or temperature and salinity constraints. In the Northern Hemisphere the oceanic heat transport was stopped by continental masses located between the Tethys, Central Atlantic and Arctic Oceans while the heat transport in the Southern Hemisphere was not limited in the Tethys Ocean. Late Albian Boreal dinoflagellates inhabited the Western Interior Sea Way, with the warming and the sea level rise Late Cenomanian Tethyan species have been recorded up to 45°N. The estimation of temperatures requirements of dinoflagellates is modelled by combining the latitudinal distribution of species, with the estimated temperatures from δ18O or TEX86 ratios related to latitude. The Early Aptian subtropical dinoflagellates inhabited water masses with temperatures higher than 22°C. Late Albian subtropical dinoflagellates lived in water masses with temperatures of 24°C and tropical species in those in temperature up to 28°C. The Late Albian arctic dinoflagellates lived in water masses with temperature lower than 19°C. Biogeography of planktonic micro-organisms coupled with temperatures estimated from δ18O or TEX86 ratios increases their potential as palaeo-oceanographic proxies for a qualitative estimation of sea-surface temperatures and palaeo-biodiversity of world water masses and improves precision in biochronology.

Masure E, Vrielynck B. 2009. Late Albian dinoflagellate cyst paleobiogeography as indicator of asymmetric sea surface temperature gradient on both hemispheres with southern high latitudes warmer than northern ones. Marine Micropaleontology 70, 120-133.

Masure E, Aumar A-M, Vrielynck B. 2013. World palaeogeography of Aptian and Late Albian dinoflagellates cysts: Implications for sea surface temperature gradient and palaeoclimate in Lewis, JM, Marret F, Bradley L (eds). Biological and Geological Perspectives of Dinoflagellates. The Micropalaeontological Society, Special Publications. Geological Society, London, 97-125.