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Supplement of

Glacial-interglacial shifts in dominant climate forcing over the last 33 ka in the northern South China Sea

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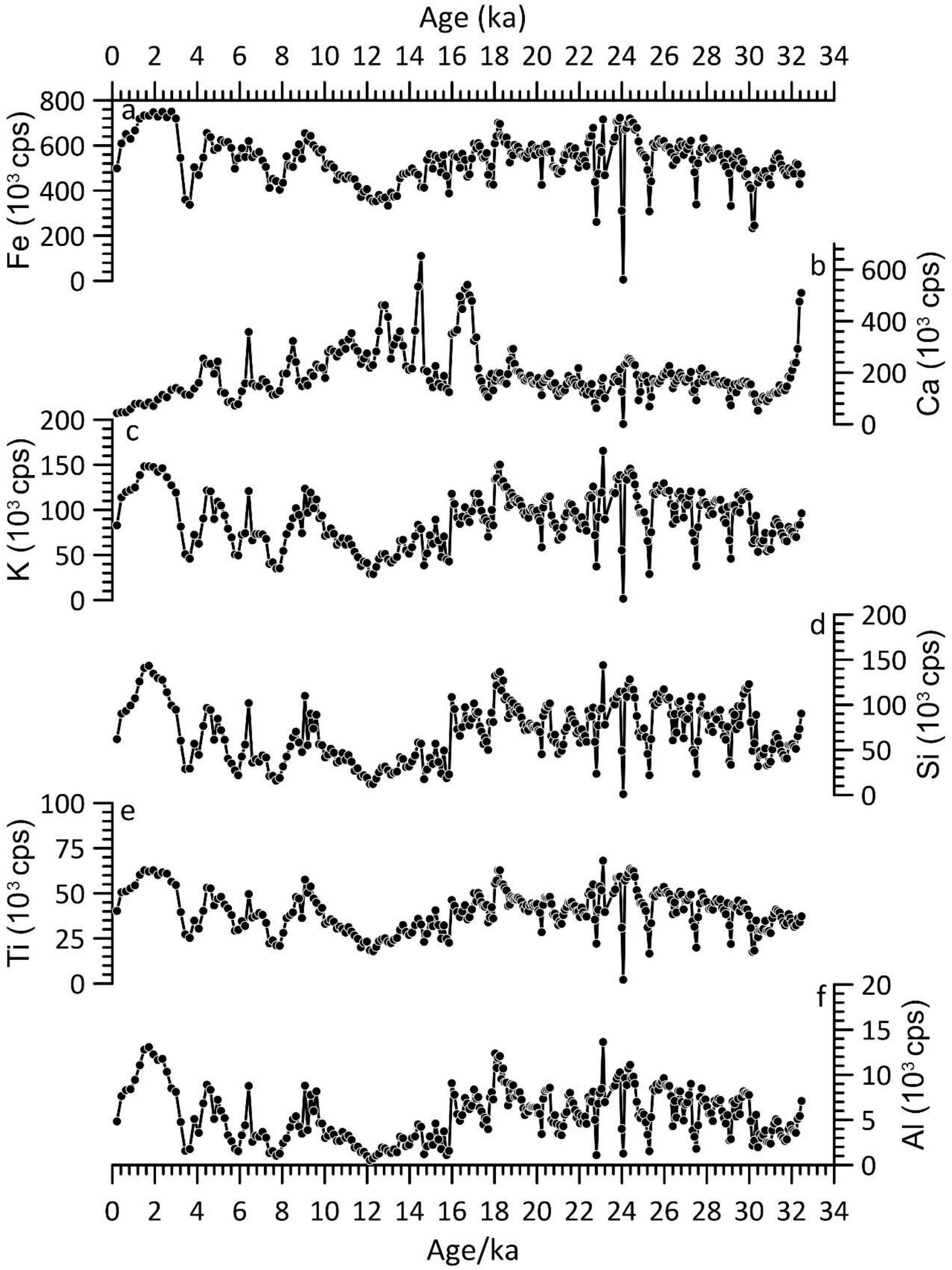

Figure S1. The relative contents of six elements in the core SCS GC-1.

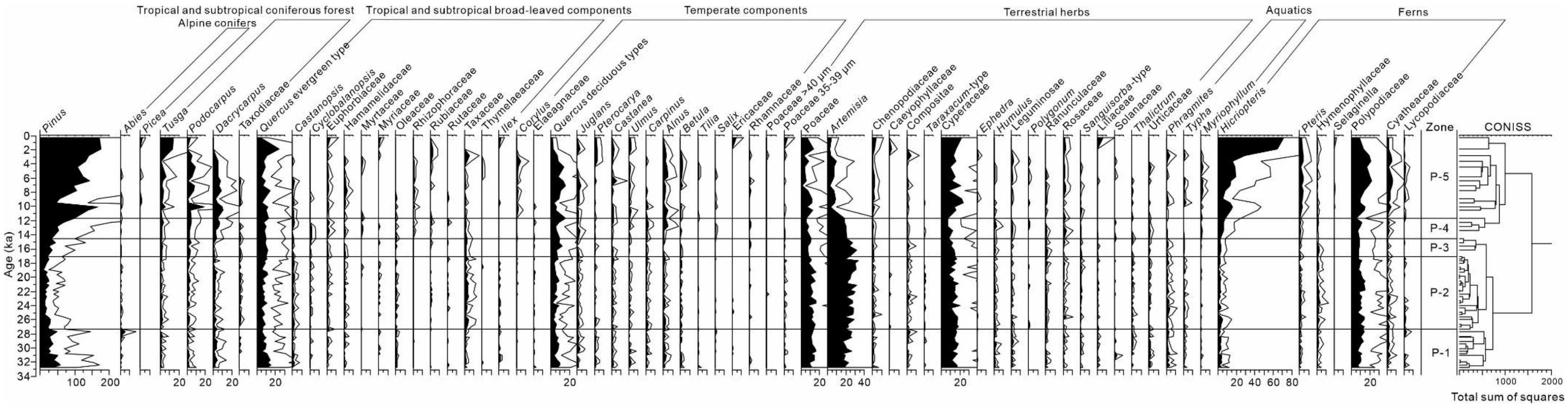

Figure S2. Percentages of pollen taxa observed in the core SCS GC-1. Lines denote three times exaggeration of percentage curves with low values. Pollen assemblage zones were conducted using the CONISS calculation.

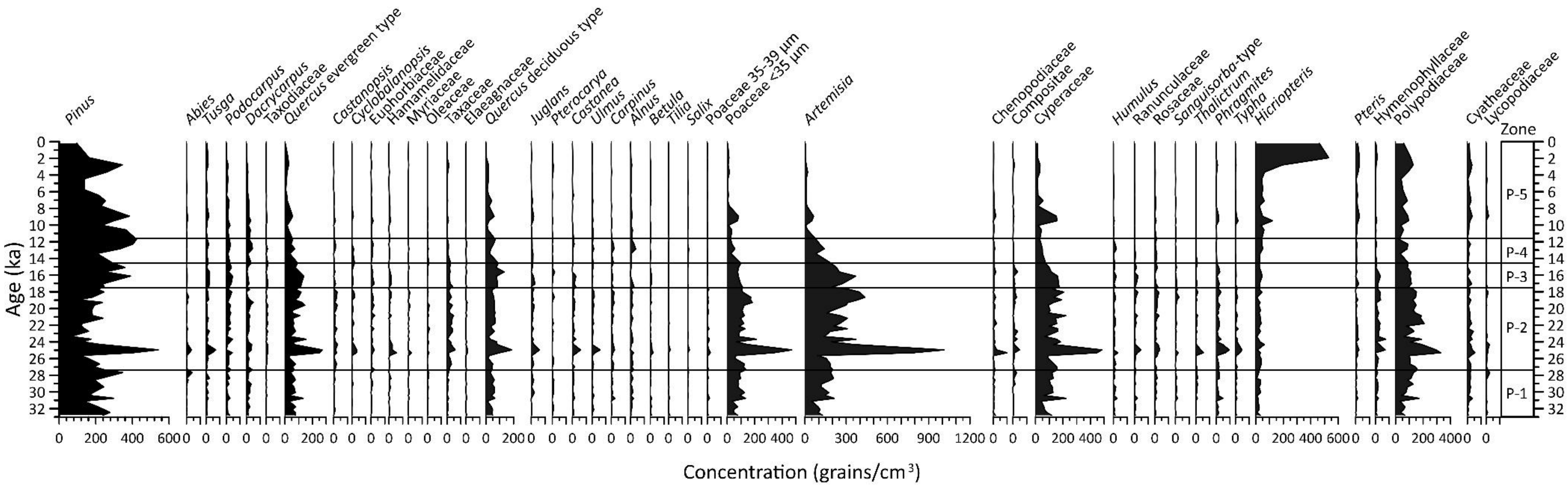

Figure S3. Concentrations of pollen taxa (with values more than 10 grains/cm^3 were shown) observed in the core SCS GC-1.

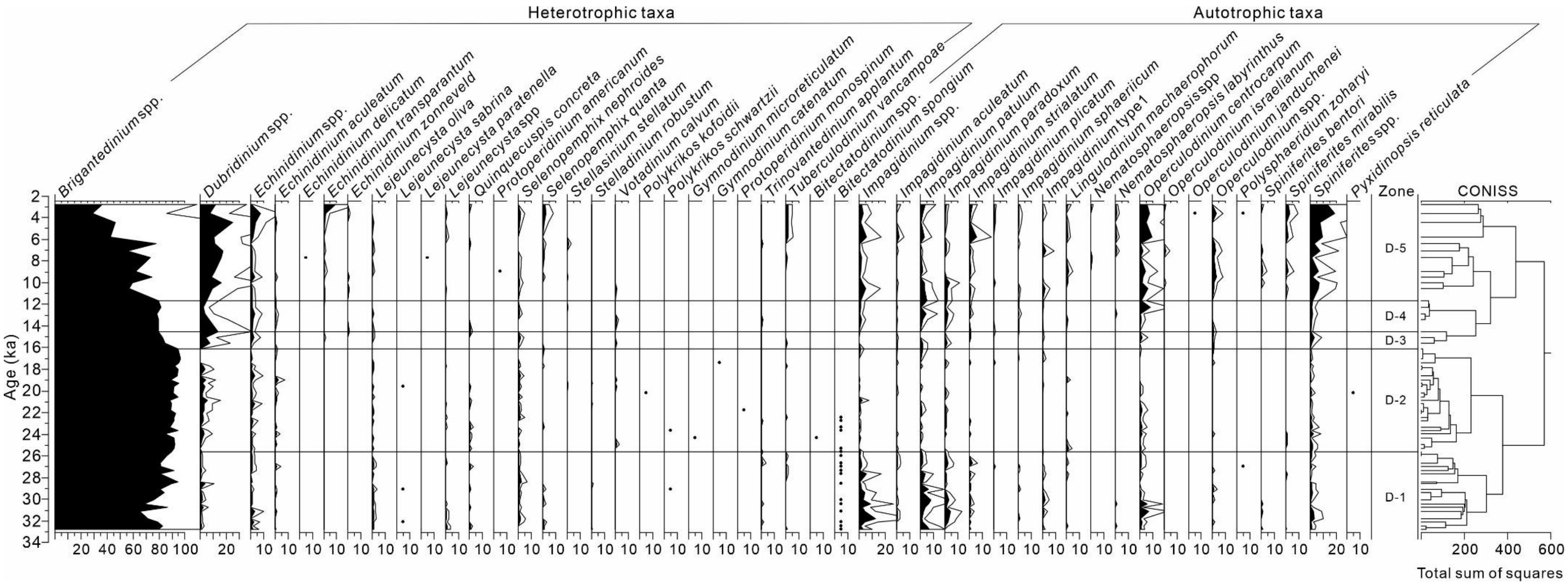

Figure S4. Percentages of dinocyst taxa in the core SCS GC-1. Lines denote three times exaggeration of percentage curves with low values, and the dots denote presence of taxa with percentage values less than 1%. Dinocyst assemblage zones were conducted using the CONISS calculation.

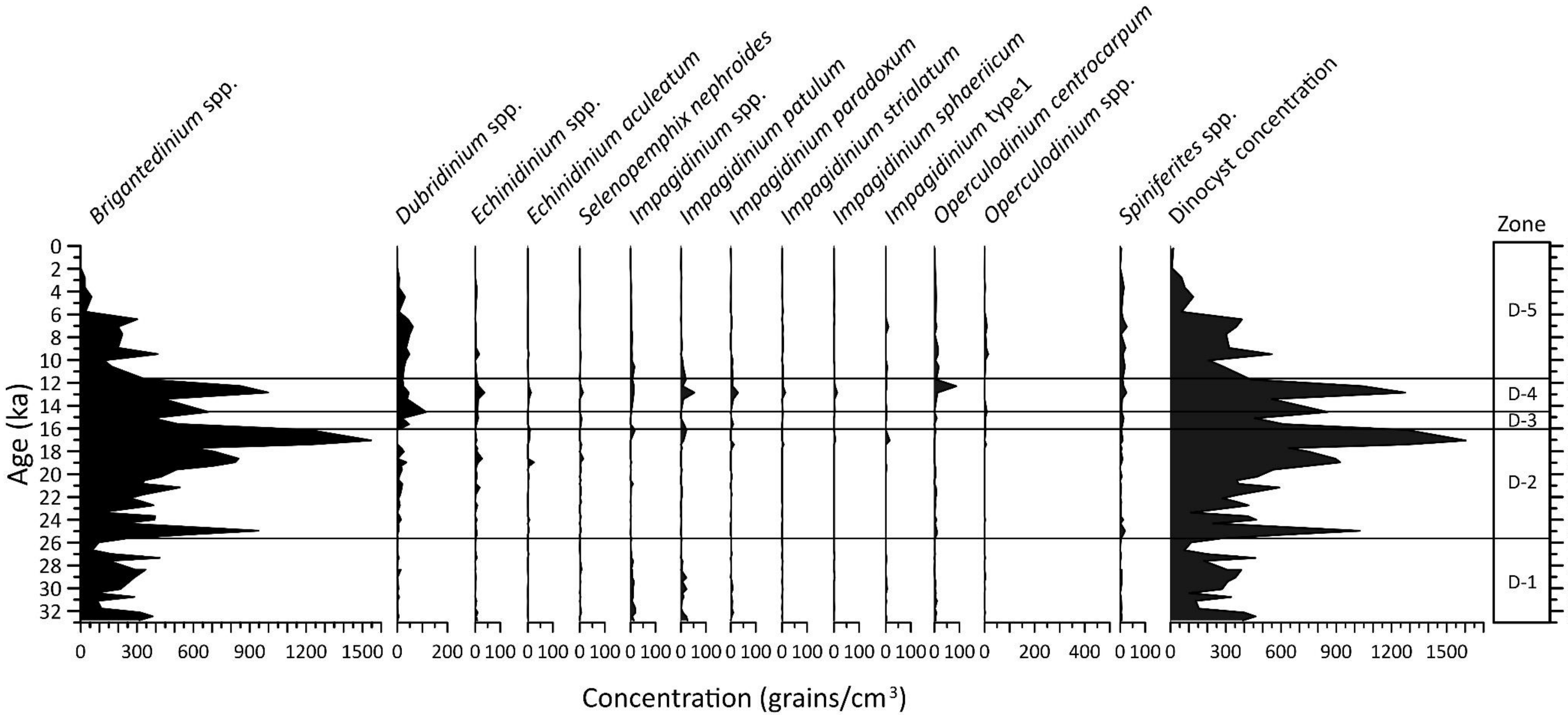

Figure S5. Concentrations of dinocyst taxa (with values more than 10 grains/cm^3 were shown) observed in the core SCS GC-1.

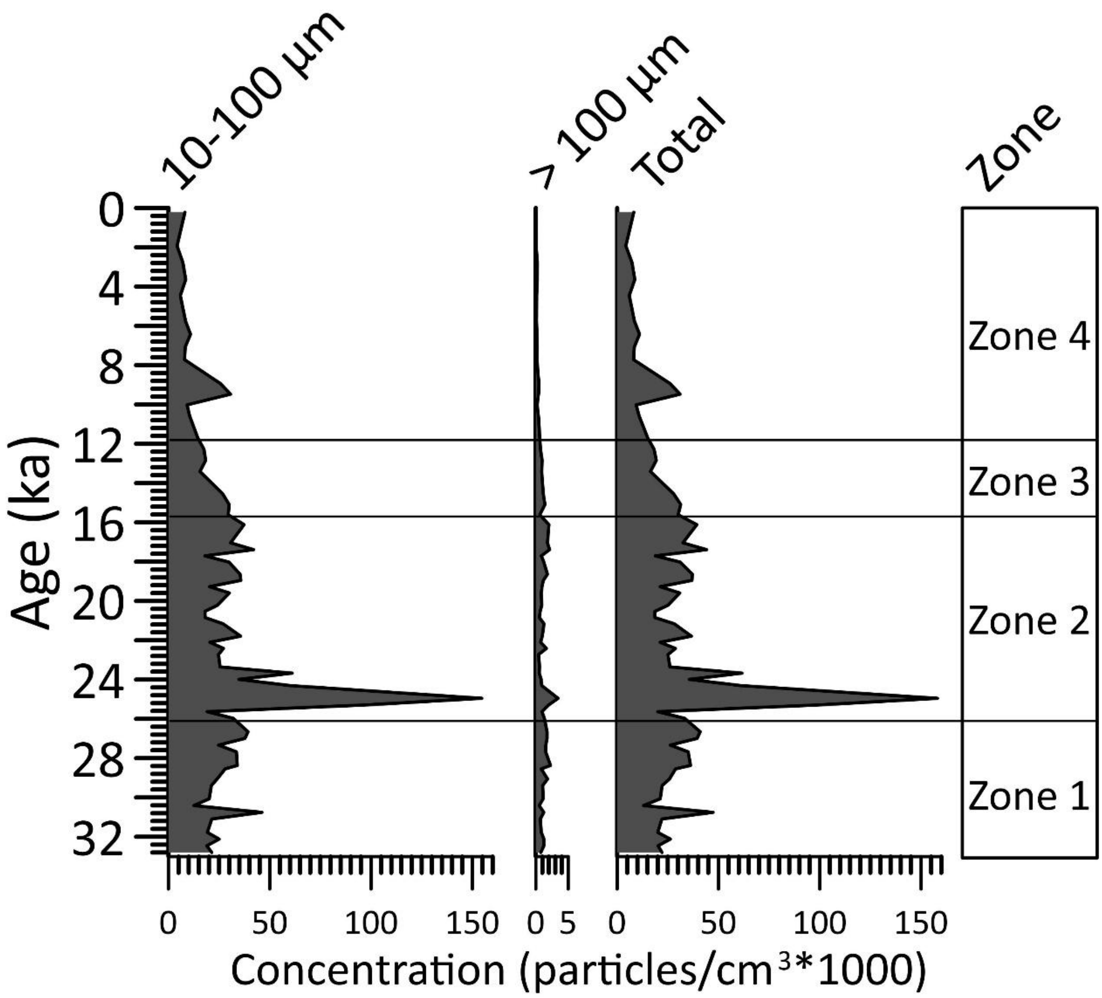

Figure S6. Microcharcoal concentrations with two size classes (10-100 µm and >100 µm) in the core SCS GC-1.

Table S1. List of organic-walled dinoflagellate cyst taxa identified in the core SCS GC-1.

Cyst name	Motile affinity	Palaeoecological interpretation	References
Protoperidiniaceae			
Brigantedinium spp.	Protoperidinium spp.	Related to upwelling or nutrient	Zonneveld and Pospelova, 2015; Marret and Zonneveld, 2003
Dubridinium spp.		Related to upwelling or nutrient	Zonneveld and Pospelova, 2015; Bouimetarhan et al. 2009
Echinidinium aculeatum	*Protoperidiniaceae*	Coastal areas with active upwelling; areas of increased nutrient and low salinity	Zonneveld and Pospelova, 2015; Pospelova and Kim, 2010
Echinidinium spp.	*Protoperidiniaceae*	Mesotrophic/eutrophic waters; upwelling	Zonneveld and Pospelova, 2015; Marret and Zonneveld, 2003
Echinidinium delicatum	*Protoperidiniaceae*	highest occurrence in the subtropics and tropics; coastal upwelling	Zonneveld and Pospelova, 2015; Verleye and Louwye, 2010
Echinidinium transparantum	*Protoperidiniaceae*	subtropical-tropical; relatively low SST and high SSS; upwelling; high productivity	Zonneveld and Pospelova, 2015; Kholeif, 2010; Bouimetarhan et al., 2009
Echinidinium zonneveldii	*Protoperidiniaceae*	Relatively low SST and high SSS; upwelling; high productivity	Zonneveld and Pospelova, 2015; Bouimetarhan et al., 2009
Lejeunecysta spp.		Shallow waters with high levels of productivity and nutrient content; freshwater inflows in estuarine environments	Zonneveld and Pospelova, 2015; Sluijs et al., 2005
Lejeunecysta oliva	*Protoperidinium sp.*	River outflow; warm, nutrient-rich, low-salinity waters	Zonneveld and Pospelova, 2015; Vink et al., 2000
Lejeunecysta sabrina	*? Protoperidinium leonis*	Temperate to tropical coastal areas	Zonneveld et al., 2013; Nieuwenhove et al., 2020
Lejeunecysta paratenella	*? Protoperidinium sp.*	Cool, nutrient-rich waters; likely related to upwelling	Zonneveld and Pospelova, 2015; Zhao et al., 2017
Quinquecuspis concreta	*? Protoperidinium leonis*	Inner-outer shallow sea, cold temperate to tropical zone; full of nutrition; river impact	Zonneveld and Pospelova, 2015; Nieuwenhove et al., 2020
Selenopemphix quanta	*Protoperidinium conicum*	Highest abundances in subtropical and tropical; nutrient-rich waters	Zonneveld and Pospelova, 2015; Zonneveld et al., 2013
Selenopemphix nephroides	*Protoperidinium subinerme*	Warm and productive shallow waters; upwelling	Zonneveld and Pospelova, 2015; Ramírez-Valencia et al., 2021
Selenopemphix stellatum		Adapted to variable salinity, meso-eutrophic, and oxygenated waters	Zonneveld and Pospelova, 2015
Stelladinium robustum	*Protoperidinium sp.*	Tropical to equatorial, mesotrophic to eutrophic environments; Increased mixing and cooling of the upper water column	Zonneveld and Pospelova, 2015; Zonneveld et al., 2013
Trinovantedinium applanatum	*Protoperidinium pentagonum*	River outflow; warm, nutrient-rich, low-salinity waters	Zonneveld and Pospelova, 2015; Vink et al., 2000
Votadinium calvum	*Protoperidinium oblongum*	Subpolar/temperate-equator; inner shallow sea/nearshore estuarine environment	Zonneveld and Pospelova, 2015; Marret and Zonneveld, 2003
Protoperidinium americanum	*Protoperidinium americanum*	High productivity and nutritional levels; coastal upwelling	Zonneveld and Pospelova, 2015; Pospelova et al., 2008
Protoperidinium monospinum	*Protoperidinium monospinum*	High nutrient in tropical-equatorial river outflow and upwelling areas	Zonneveld and Pospelova, 2015; Zonneveld et al., 2013
Pyxidinopsis reticulata		Eurythermal; High-salinity tolerant	Zonneveld et al., 2013
Polykrikaceae			
Polykrikos kofoidii	*Polykrikos kofoidii*	Nutrient-rich upwelling conditions in temperate to subtropical regions; inner shallow sea	Zonneveld and Pospelova, 2015; Marret and Zonneveld, 2003

Polykrikos schwartzii	*Polykrikos schwartzii*	Nutrient-rich upwelling conditions in temperate to subtropical regions	Zonneveld and Pospelova, 2015; Marret and Zonneveld, 2003
Gymnodiniaceae			
Gymnodinium microreticulatum	*Gymnodinium microreticulatum*	Coastal areas in temperate to subtropical, oligotrophic to mesotrophic regions	Zonneveld and Pospelova, 2015; Zonneveld et al., 2013
Gymnodinium catenatum	*Gymnodinium catenatum*	It inhabits tropical/subtropical high-productivity marine areas, has a low tolerance for temperature/salinity fluctuations, and its survival strictly depends on nutrient-rich waters brought by upwelling or vertical mixing.	Zonneveld et al., 2013
Gonyaulacaceae			
Bitectatodinium spongium		Prefers warm and saline environments; fully marine environments	Zonneveld et al., 2013
Impagidinium spp.	*Gonyaulax sp.*	Oligotrophic marine; sea level rise	Zonneveld and Pospelova, 2015; Powell et al., 1996
Impagidinium aculeatum	*Gonyaulax sp.*	Relatively warm, high-salinity, oligotrophic open-ocean environments	Zonneveld et al., 2013
Impagidinium paradoxum	*Gonyaulax sp.*	A species with broad temperature tolerance, high-salinity marine habitat preference, and optimal growth in oligotrophic waters	Zonneveld et al., 2013
Impagidinium patulum	*Gonyaulax sp.*	Warm, high-salinity, oligotrophic open-ocean preference	Zonneveld et al., 2013
Impagidinium plicatum	*Gonyaulax sp.*	There existed warm, normal-salinity, nutrient-depleted oligotrophic sea areas	Zonneveld et al., 2013
Impagidinium sphaericum	*Gonyaulax sp.*	A species widely distributed in the open ocean, characterized as eurythermal and eurytrophic, with a preference for eutrophic marine environments	Zonneveld et al., 2013
Impagidinium strialatum	*Gonyaulax sp.*	An oligotrophic species distributed in the low- to mid-latitude open ocean, adapted to temperate and tropical climates	Zonneveld et al., 2013
Lingulodinium machaerophorum	*Lingulodinium polyedrum*	Inner shallow sea; tropical-subtropical; high productivity	Zonneveld and Pospelova, 2015; Marret and Zonneveld, 2003
Nematosphaeropsis labyrinthus	*Gonyaulax spinifera*	Tropical and subtropical; oligotrophic marine; sea level rise	Zonneveld and Pospelova, 2015; Wall et al., 1977
Operculodinium spp.		Open ocean; cosmopolitan species	Zonneveld and Pospelova, 2015; Wall et al., 1977
Operculodinium centrocarpum	*Protoceratium reticulatum*	Cosmopolitan species; intersection of oceanic and shallow water masses, cold/temperate zones, higher nutrients	Zonneveld and Pospelova, 2015; Zonneveld et al., 2013
Operculodinium janduchenei		Temperate-equatorial; oligotrophic to eutrophic environment	Zonneveld and Pospelova, 2015; Zonneveld et al., 2013
Operculodinium israelianum	*?Protoceratium sp.*		Zonneveld et al., 2013
Polysphaeridium zoharyi	*Pyrodinium bahamense*	Subtropical inner shallow sea; declined abundance with rising sea levels; typical lagoon and shallow water species	Zonneveld and Pospelova, 2015; Wall et al., 1977
Spiniferites bentori	*Gonyaulax sp.*	Warm conditions	Zonneveld and Pospelova, 2015
Spiniferites mirabilis	*Gonyaulax spinifera complex*	Warm conditions; shallow to ocean area	Zonneveld and Pospelova, 2015; Marret and Zonneveld, 2003
Spiniferites spp.	*Gonyaulax spp.*	Outer shallow sea; high SST, weak upwelling and fully oceanic conditions	Zonneveld and Pospelova, 2015; Zonneveld et al., 2013
Tuberculodinium vancampoae	*Pyrophacus steinii*	Tropical to subtropical; inner shallow seas and lagoons	Zonneveld and Pospelova, 2015; Versteegh and Zonneveld, 1994

SST: sea surface temperature; SSS: sea surface salinity.