Journal of Global Change Data & Discovery. 2017, 1(1): 80-85
DOI:10.3974/geodp.2017.01.12
www.geodoi.ac.cn

Sediment Core ARC3-P23 Paleoenvironmental Research Dataset from the Chukchi Plateau in the Western Arctic Ocean

Zhang, T. L. Wang, R. J.* Xiao, W. S. Sun, Y. C.

State Key Laboratory of Marine Geology, Tongji University, Shanghai 200092, China

Abstract: The Arctic Ocean plays an important role in global atmospheric and thermohaline circulation, as well as in climatic evolution. It both drives and responds to global change. The paleoenvironmental study of the Arctic Ocean reported in this paper will help us to understand long-term climate change in this area and its role in the global climate system, thus providing important constraints for future climate modeling. Multi-proxy investigations and regional core correlations have been performed on sediment core ARC3-P23, which was collected from the Chukchi Plateau in the Western Arctic Ocean during the Third Chinese National Arctic Expedition cruise. The core was dated back to Marine Isotope Stage (MIS) 3 in order to reconstruct the terrigenous input and paleo-water mass of the study area. The dataset consists of physical and chemical parameters, as well as paleoenvironmental proxies from core ARC3-P23. The data includes: XRF core scanner results, $CaCO_3$%, coarse fraction, foraminiferal abundance, stable oxygen and carbon isotopes of planktonic foraminifera Neogloboquadrina pachyderma sinistral (NPS), and NPS AMS14C dating results. The dataset is archived in .xls format and is 0.131 MB in size.

Keywords: Chukchi Plateau; MIS 3; IRD events; oxygen and carbon isotopes; water mass changes

1 Introduction

The Arctic Ocean plays an important role in global atmospheric and thermohaline circulation, as well as in climatic evolution. It also drives and responds to global change[1–3]. Interactions between the Arctic and the global climate occur in two ways. First, sea ice increases the albedo of earth and influences the global heat balance. Second, Pacific and Atlantic waters, which flow through the Arctic Ocean, influence the global thermohaline[4–6]. Over the past decade, global warming has been significantly amplified in the Arctic by a dramatic decline in sea ice[7]. The Arctic directly influences the global environment and climate[8]. Thus, it has

Received: 10-10-2014; **Accepted:** 17-12-2014; **Published:** 25-03-2017
Foundation(s): State Oceanic Administration of P. R. China (CHINARE2013-03-02)
***Corresponding Author:** WANG, R. J. A-4207-2017, State Key Laboratory of Marine Geology, Tongji University, rjwang@tongji.edu.cn
Article Citation: Zhang, T. L., Wang, R. J., Xiao, W. S., *et al*. Sediment core ARC3-P23 paleoenvironmental research dataset from the Chukchi Plateau in the western Arctic Ocean [J]. *Journal of Global Change Data & Discovery*, 2017, 1(1): 80−85. DOI: 10.3974/geodp.2017.01.12.
Dataset Citation: Zhang, T. L., Wang, R. J., Xiao, W. S., *et al*. Paleoenvironment dataset from the ARC3-P23 sample in Chukchi Oceanic Plateau of western Arctic [DB/OL]. Global Change Research Data Publishing & Repository, 2014. DOI: 10.3974/geodb.2014.02.13.V1.

become a research hotspot because of both its environmental significance and the increasing availability of field investigation data. In recent years, Arctic paleoceanographic studies have focused primarily on the Eastern Arctic Ocean. Very few studies have been performed in the Western Arctic Ocean. This dataset consists of paleoenvironmental data from sediment core ARC3-P23, which was collected from the Chukchi Plateau in the Western Arctic Ocean during the Third Chinese National Arctic Expedition cruise. This dataset aids in research on ice rafted detritus (IRD) events, mater mass evolution, and in reconstructing the paleoenvironment of the Late Quaternary Period in the Western Arctic Ocean.

2 Metadata of Dataset

The Sediment Core ARC3-P23 Paleoenvironmental Research Dataset from the Chukchi Plateau in the Western Arctic Ocean includes physical and chemical parameters, as well as paleoenvironmental proxies from core ARC3-P23[9]. Table 1 summarizes the main metadata elements of the dataset.

Table 1 Metadata summary of the ARC3-P23_Env_Data

Items	Description
Dataset full name	Sediment core ARC3-P23 paleoenvironmental research dataset from the Chukchi Plateau in the Western Arctic Ocean
Dataset short name	ARC3-P23_Env_Data
Authors	Zhang, T. L. R-7607-2016, State Key Laboratory of Marine Geology, Tongji University, ztl1989@hotmail.com Wang, R. J. A-4207-2017, State Key Laboratory of Marine Geology, Tongji University, rjwang@tongji.edu.cn Xiao, W. S. A-4650-2017, State Key Laboratory of Marine Geology, Tongji University, wxiao@tongji.edu.cn Sun, Y. C. A-3561-2017, State Key Laboratory of Marine Geology, Tongji University, 10084@tongji.edu.cn
Geographical region	76°20.14′N, 162°29.16′W, 2,089 m water depth, the Chukchi Plateau, Western Arctic Ocean
Time	2008
Data format	.xls
Data size	132 KB
Data files	The Paleoenvironment Research Dataset of Sediment Core ARC3-P23 from the Chukchi Plateau, Western Arctic Ocean consists of physical and chemical parameters, as well as paleoenviromental proxies from core ARC3-P23. Four files are included: 1. XRF core scanner data from core ARC3-P23, 74 KB 2. $CaCO_3$%, coarse fraction, and foraminiferal abundance in core ARC3-P23, 33 KB 3. Stable oxygen and carbon isotopes of planktonic foraminifera NPS in core ARC3-P23, 16 KB 4. NPS AMS^{14}C dating results from core ARC3-P23, 9 KB
Foundation(s)	State Oceanic Administration of P. R. China (CHINARE2013-03-02)
Data Publisher	Global Change Research Data Publishing & Repository, http://www.geodoi.ac.cn
Address	No.11A, Datun Road, Chaoyang District, Beijing 100101, China.
Data sharing policy	***Data*** from the Global Change Research Data Publishing & Repository includes metadata, datasets (data products), and publications (in this case, in the *Journal of Global Change Data & Discovery*). ***Data*** sharing policy includes: (1) ***Data*** are openly available and can be free downloaded via the Internet; (2) End users are encouraged to use ***Data*** subject to citation; (3) Users, who are by definition also value-added service providers, are welcome to redistribute ***Data*** subject to written permission from the GCdataPR Editorial Office and the issuance of a ***Data*** redistribution license; and (4) If ***Data*** are used to compile new datasets, the 'ten per cent principal' should be followed such that ***Data*** records utilized should not surpass 10% of the new dataset contents, while sources should be clearly noted in suitable places in the new dataset[10]

3 Methods

3.1 Date Collection

The gravity core 08P23 (76°20.14′N, 162°29.16′W, 2,086 m water depth)[11] was collected from the Southern Chukchi Plateau during the Third Chinese National Arctic Expedition cruise (Figure 1). The total core length is 294 cm, and a total of 147 samples were taken from the core at 2 cm intervals.

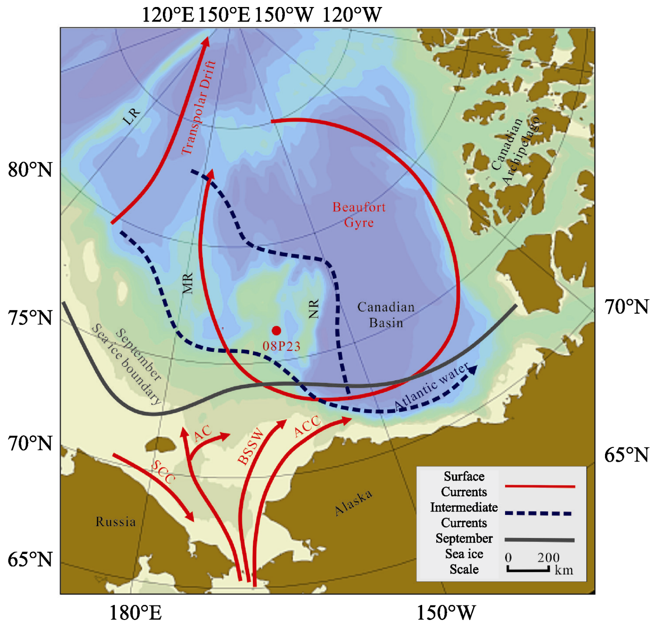

Figure 1 Core ARC3-P23 site map showing oceanographic parameters and the September sea ice distribution. Solid red lines show surface currents and dotted lines show intermediate water CP: Chukchi Plateau; NR: Northwind Ridge; MR: Mendeleev Ridge; LR: Lomonosov Ridge; AC: Anadry Current; BSSW: Bering Sea Shelf Water; ACC: Alaska Coastal Current; SCC: Siberian Coastal Current

3.2 Materials and Methods

The analysis of core 08P23 includes: XRF core scanning, $CaCO_3$%, coarse fraction (> 63 μm, > 150 μm, and > 250 μm) content, foraminiferal abundance, stable oxygen and carbon isotopes of planktonic foraminiferal Neogloboquadrina pachyderma sinistral (NPS), and AMS ^{14}C dating.

The relative elemental content of the split half core was measured using an AVAATECH® non- destructive X-ray fluorescence (XRF) core scanner at a resolution of 1 cm. Measurements were carried out at 10 kV, 30 kV, and 50 kV, with measurement times of 30 s for each energy level, in order to register a wide range of elements (Al to U). The data are represented as counts/30 s.

The bulk $CaCO_3$ content (%) was determined via the gasometrical method (Jones and Kaiteris, 1983) using a French carbonate analyzer (NFP18-508) with an estimated error of < 2%. About 0.1 g of a bulk sample was reacted with 3 N HCl. The CO_2 volume was measured to calculate the $CaCO_3$ content. The absolute $CaCO_3$ content was calculated using the equation: $CaCO_3\% = V/(22.4 \times 103) \times 100/M$, where V is the CO_2 gas volume (mL), and M is the sediment weight (g).

About 10–15 g of dry sediment was wet-rinsed through a Φ 63 μm mesh, and the >63 μm residue was dry-sifted through successive Φ 150 μm and Φ 250 μm meshes. Foraminifers in the 150−250 μm and >250 μm fractions were separated and counted under the microscope. The residual coarse fractions, which are considered IRD (>150 μm and >250 μm), were weighed and their contents (% of dry sediment) were calculated.

Stable oxygen and carbon isotopes were measured via 20 NPS tests (150−250 μm) using a Finnigan MAT252 mass spectrometer. The isotope results are reported to the Pee Dee Belemnite (PDB) standard. The standard errors for $\delta^{18}O$ and $\delta^{13}C$ are 0.08% PDB and 0.06% PDB, respectively.

AMS ^{14}C was measured using NPS shells (150–250 μm) from core depths of 0–2 cm, 8–10 cm, and 12–14 cm.

AMS ^{14}C dating was performed at the Earth System Science Department of UC Irvine. The remaining analyses were carried out in the State Key Laboratory of Marine Geology, Tongji University.

4 Dataset Compositions, Quality Control and Validation

4.1 Dataset Compositions

The Paleoenvironment Research Dataset of Sediment Core ARC3-P23 from the Chukchi Plateau, Western Arctic Ocean consists of physical and chemical parameters, as well as paleoenvironmental proxies from core ARC3-P23, including: 1. XRF scan data from core ARC3-P23 (Table 2), 74 KB; 2. $CaCO_3$%, coarse fraction, and foraminiferal abundance in core ARC3- P23 (Table 3), 33 KB; 3. Stable oxygen and carbon isotopes of planktonic foraminifera NPS in core ARC3-P23 (Table 4), 16 KB; and 4. AMS^{14}C dating results from NPS in core ARC3-P23 (Table 5), 9 KB.

4.2 Data Validation

The AMS ^{14}C calibration of planktonic foraminifera NPS in this dataset refers to Coulthard *et al*., 2010[15] and Fairbanks *et al*., 2005[16]. The reservoir-corrected ^{14}C age is 790 yrs.

Table 2 XRF core scanner results from core ARC3-P23 (excerpt)

Depth (cm)	Al_Area	Si_Area	P_Area	Cl_Area	K_Area	Ca_Area	Mn_Area	Fe_Area
0–1	1,678	15,906	109	10,409	11,132	12,002	8,332	51,587
1–2	1,910	17,307	94	11,459	12,294	13,625	9,453	57,347
2–3	1,913	19,100	49	11,530	12,996	14,404	9,267	58,078
3–4	1,993	19,533	128	11,294	13,125	15,429	9,281	57,781
4–5	2,090	19,410	111	10,517	13,169	14,588	8,797	56,908
5–6	2,045	20,130	194	10,338	13,333	17,707	7,881	55,131
6–7	2,284	21,042	137	10,427	14,451	16,013	6,912	55,917
7–8	1,996	18,745	121	9,496	13,883	14,726	5,188	53,855
8–9	1,178	12,776	33	7,119	10,833	13,879	3,798	43,313
9–10	1,180	12,750	39	5,927	10,198	16,700	2,117	39,509

Table 3 $CaCO_3$%, foraminiferal abundance in core ARC3-P23 (excerpt)

Depth (cm)	IRD>63 μm (%)	IRD>250 μm (%)	PF (shells/g)	BF (shells/g)	$CaCO_3$% (%)
0–2	4.77	0.91	4,869.86	179.70	10.05
2–4	5.05	0.86	1,735.17	61.97	10.20
4–6	6.25	1.84	2,596.63	100.64	10.70
6–8	6.71	1.43	1,912.18	57.94	13.54
8–10	4.92	1.02	2,301.89	52.83	9.74
10–12	3.07	0.63	1,511.83	66.26	9.70
12–14	3.54	0.81	364.98	27.81	9.57
14–16	8.18	4.88	82.59	9.18	10.53
16–18	1.74	0.23	5.43	0.49	7.56
18–20	3.20	0.77	7.58	0.51	7.55

PF: planktonic foraminiferal abundance, BF: benthic foraminiferal abundance.

Table 4 Stable oxygen and carbon isotopes in planktonic foraminifera NPS from core ARC3-P23 (excerpt)

Depth (cm)	Species	$\delta^{13}C$	$\delta^{18}O$
0–2	N. pachyderma(sin)	1.075	1.553
2–4	N. pachyderma(sin)	1.063	1.329
4–6	N. pachyderma(sin)	0.959	1.351
6–8	N. pachyderma(sin)	1.008	1.047
8–10	N. pachyderma(sin)	0.812	0.806
10–12	N. pachyderma(sin)	0.550	1.386
12–14	N. pachyderma(sin)	0.231	1.569
14–16	N. pachyderma(sin)	0.277	1.742
16–18	N. pachyderma(sin)	0.428	1.545
18–20	N. pachyderma(sin)	0.629	1.735

Table 5 AMS ^{14}C dating results from NPS in core ARC3-P23

Sample ID	Depth/cm	AMS ^{14}C age/a BP	Reservoir corrected ^{14}C age/a BP	Calibrated age/a BP
UCIT24020	0–2	3,455±15	2,665±15	2,761±8
UCIT24022	4–6	5,915±15	5,125±15	5,897±18
UCIT24024	8–10	8,650±20	7,860±20	8,621±21
UCIT24026	10–12	10,680±20	9,890±20	11,261±19

5 Discussion and Conclusion

The relative Mn%, IRD%, foraminiferal abundance, and AMS 14C results from Core 08P23 were correlated with that of Core 03M03, and a stratigraphic framework was established for Core 08P23. Sediments from 0–14 cm, 14–60 cm, and 60–294 cm represent MIS 1, MIS 2, and MIS 3, respectively. A delay between MIS 2 and MIS 3 is assumed. This delay may have resulted from thick ice covering the study area during the LGM.

As shown by the NPS-$\delta^{18}O$ and -$\delta^{13}C$, IRD%, and foraminiferal abundance results in Core 08P23, the depletion of NPS-$\delta^{18}O$ and -$\delta^{13}C$ in the three brown units within MIS 1 and MIS 3 result from water-melting events. The NPS-δ18O and -δ13C values between B2a and B2b in MIS 3 indicate enhanced sea ice formation, which causes production and sinking of isotopically lighter brine. A rapid drop in SST during MIS 2 leads to heavier NPS-δ18O.

A total of 5 prominent IRD events are recognized in MIS 2 and MIS 3, including IRD 2/3 and IRD 7-IRD 10. The high detrital carbonate content originates from vast Paleozoic carbonate rock outcroppings in the Canadian Arctic Archipelago. They were carried via sea ice or icebergs and brought to the Chukchi Plateau by the Beaufort Gyre. The clastic quartz in IRD 2/3 may originate from Eurasia.

Author Contributions

Zhang, T. L. performed the experimental design and data analysis, and created the data paper; Wang, R. J. and Xiao, W. S. performed the dataset development and data validation, and created part of the data paper; Sun, Y. C. performed the sample collection and data pre-processing.

Acknowledgements

This work is part of "the Third Chinese National Arctic Research Expedition" (CHINARE-2008) sponsored by the National Ministry of Finance of China and organized by the Chinese Arctic and Antarctic Administration (CAA), with participation of PRIC, FIO, SIO, TIO, and Tongji University. We thank members of the CHINARE-2008 cruise for collecting samples.

References

[1] Moritz, R. E., Bitz, C. M., Steig, E. J. Dynamics of recent climate change in the Arctic [J]. *Science*, 2002, 297(5586): 1497–1502.

[2] Laxon, S., Peacock, N., Smith, D. High interannual variability of sea ice thickness in the Arctic region [J]. *Nature*, 2003, 425(6961): 947–950.

[3] Chen, L. Q. Marine Environment and Air-Sea Interaction in the Arctic Region [M]. Beijing: China Ocean Press, 2003.

[4] Delworth, T. L. S., Manabe, S., Stouler, R. J. Multidecadal climate variability in the Greenland Sea and Surrounding regions: a coupled simulation [J]. *Geophysical Research Letters*, 1997, 24(3): 257–260.

[5] Smith, L. M., Miller, G. H. Otto-Bliesner B., *et al*. Sensitivity of the northern hemisphere climate system to extreme changes in Holocene Arctic sea ice [J]. *Quaternary Science Reviews*, 2002, 22(5–7): 645–658.

[6] Gao, A. G., Liu, Y. G., Sun, H. Q. Some marine geology issues related to global change in Arctic Ocean [J]. *Earth Science Frontier*, 2002, 9(3): 201–207.

[7] Ke, C. Q., Peng, H. T., Sun, B., *et al*. Spatial-temporal variability of Arctic sea ice from 2002 to 2011 [J]. *Journal of Remote Sensing*, 2013, 17(2): 459–466.

[8] Chen, L. Q., Zhao, J. P., Bian, L. G., *et al*. Study on key processes affecting rapid changes in the Arctic [J]. *Chinese Journal of Polar Research*, 2003, 15(4): 283–302.

[9] Zhang, T. L., Wang, R. J., Xiao, W. S., *et al*. Paleoenvironment dataset from the ARC3-P23 sample in Chukchi Oceanic Plateau of western Arctic [DB/OL]. Global Change Research Data Publishing & Repository, 2014. DOI: 10.3974/geodb.2014.02.13.V1.

[10] GCdataPR Editorial Office. GCdataPR data sharing policy [OL]. DOI: 10.3974/dp.policy.2014.05 (Updated 2017).

[11] Zhang, H. S. The Report of 2008 Chinese Arctic Research Expedition [M]. Beijing: China Ocean Press, 2009.

[12] Jones, E. P. Circulation in the Arctic Ocean [J]. *Polar Research*, 2001, 20(2): 139–146.

[13] Woodgate, R. A., Aagaard, K., Weingrtner, T. A year in the physical oceanography of the Chukchi Sea: moored, measurements from autumn 1990–1991 [J]. *Deep Sea Research*, 2005, 52(24/26): 3116–3149.

[14] Parkinson, C. L., Cavalieri, D. J. Arctic sea ice variability and trends, 1979–2006 [J]. *Journal of Geophysical Research*, 2008, 113(C7): 341–355.

[15] Coulthard, R. D., Furze, M. F. A., Pienkowski, A. J., *et al*. New marine ΔR values for Arctic Canada [J]. *Quaternary Geochronology*, 2010, 5(4), 419–434.

[16] Fairbanks, R. G., Mortlock, R. A., Chiu, T. C., *et al*. Radiocarbon calibration curve spanning 0 to 50,000 years BP based on paired Th-230/U-234/U-238 and C-14 dates on pristine corals [J]. *Quaternary Science Reviews*, 2005, 24(16/17): 1781–1796.