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High-resolution scanning and lithological data of lake sedimentary cores from the Schirmacher Oasis, Dronning Maud Land, East Antarctica

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Abstract: The Schirmacher Oasis, marked by numerous lakes, located in Dronning Maud Land, provides excellent opportunities to address the past variability of the East Antarctic Ice Sheet. During the austral summer season in 2019, an international collaborative project entitled “Schirmacher Oasis Nippon (Japan) India Coring (SONIC) Expedition” between Japan and India carried out intensive fieldwork in the Schirmacher Oasis based out from Maitri, the Indian research station. A total of 20 sedimentary cores were retrieved from nine lakes in the Schirmacher Oasis by using a newly developed percussion piston corer. Among them, fifteen cores were transported to Japan by airplane, and several non-destructive analyses and visual descriptions were conducted at the Marine Core Research Institute, Kochi University. In this report, we compile these core data to present basic information for further research on ice-sheet variability.

1. Background and Summary

Reconstructing past variability of the Antarctic Ice Sheet (AIS), in particular, the East Antarctica Ice Sheet (EAIS), which occupies ~90% of the total AIS volume, is essential to understand its stability and to predict its contribution to future sea-level change (e.g., Mackintosh *et al.*, 2014[1]). A number of studies have reported significant temporal variation in the thickness and extent of the EAIS in Dronning Maud Land (DML) since the last glacial period (e.g., Altmaier *et al.*, 2010[2]; Anderson *et al.*, 2020[3]; Ishiwa *et al.*, 2021[4]; Kawamata *et al.*, 2020[5]; Miura *et al.*, 1998a[6], 1998b[7]; Sproson *et al.*, 2021[8]; Suganuma *et al.*, 2014[9]; Suganuma *et al.*, 2022[10]; Yamane *et al.*, 2011[11]) (Figure 1), however the maximum geographical extent of EAIS during the Last Glacial Maximum (LGM) and the subsequent melting history have not been well constrained. The presence of over 108 lakes in the Schirmacher Oasis in DML provides excellent opportunities to address this fundamental question (Figure 2). Although only a few lakes have been cored and studied in detail due to limitations in accessing them, the sediments of the lakes are envisaged to provide a continuous history from not only the LGM (e.g., Phartiyal *et al.*, 2011[12]; Phartiyal, 2014[13]), but also from the last glacial period (e.g., Mahesh *et al.*, 2017[14]; 2019[15]; Warrier *et al.*, 2014[16]; 2021[17]). Therefore, long sedimentary records from the lakes in the Schirmacher Oasis will be a key for understanding EAIS history and reconstructing the various environmental changes since the Last Interglacial.

The Schirmacher Oasis Nippon (Japan) India Coring (SONIC) expedition, an international collaborative project between Japan and India, carried out intensive fieldwork in the Schirmacher Oasis during the austral summer season in 2019 based out from Maitri, the Indian research station. During the SONIC expedition, 20 sedimentary cores were recovered from proglacial, land-locked, and epi-ice shelf lakes by using a newly developed percussion piston corer (Suganuma *et al.*, 2019[18]) from a frozen lake water surface. The new corer could retrieve a sediment core with a diameter of 65 mm and a length of up to 8 m during the SONIC expedition. After retrieval of these lake sediment cores, fifteen cores were transported to Japan by airplane under cool (+4˚C) or cold (–18˚C) temperatures for non-destructive analyses and visual core descriptions. The remaining cores were sent to India. This report covers the data from the fifteen sedimentary cores acquired during the SONIC expedition.

2. Location and observation

The Schirmacher Oasis is a large ice-free area located close to the present grounding line of the Nivlisen ice shelf and has the over 108 proglacial, land-locked, and epi-ice shelf lakes (Figure 2). The SONIC project carried out sediment coring in nine lakes and obtained 20 cores. Some of the long cores were cut into two sections so that each section would be less than 1.5 m long, making it easier to transport. Among the obtained cores, fifteen were transported to the National Institute of

Polar Research and subsequently to the Marine Core Research Institute, Kochi University (MaCRI) (previously known as the Center for Advanced Marine Core Research) in Japan for preliminary analysis and sub-sampling. All core locations and core information are listed in Table 1.

3. Methods

We carried out computerized tomographic (CT) scanning for whole sediment cores, and then the sedimentary cores were longitudinally split into working and archive halves. The archive half-cores were used for the gamma density and magnetic susceptibility measurements, as well as photo scanning. The working-half cores were used for the lithological description of the sediments. Then, subsamples were collected from the working half-cores with 1 cm slices for later analyses.

3.1. CT scanning and CT value calculation

CT scanning of the sediment cores was carried out using the Aquilion PRIME Focus Edition designed by CANON MEDICAL SYSTEMS CORPORATION. The slice interval is 0.5 mm, and the spatial resolution of the scanning is approximately 0.16 mm. The CT data were visualized using Osirix software (Rosset *et al.*, 2004[19]), and then the CT values were extracted from the center of the core slices. The CT average values (CT_ave_value in the table) were also calculated within a radius of approximately 1.6 cm from the core center (equivalent to 100 pixels) using Pydicom software (refer to Ishiwa *et al.*, 2022[20] for more detailed information).

3.2. Multi-Sensor Core Logger (MSCL)

The gamma density (bulk density) and magnetic susceptibility of the sediment cores were continuously measured using a sensor for gamma ray attenuation (GRA) and a point sensor (MS2E) that are paired to the Bartington MS3 meter with the Geotek multi-sensor core logger (MSCL) system (e.g., Ishiwa *et al.*, 2016[21], Oiwane *et al.*, 2014[22]). The sediment cores were transported on a stepper-motor-driven tracking system, and the data were collected at 1 cm intervals. The GRA densitometer used a 10 mCi ^{137}Cs capsule as the gamma ray source (with the principal energy peak at 0.662 MeV) and a scintillation detector (See Oiwane *et al.*, 2014[22] for more details of the analysis).

3.3. Photo scanning and color reflectance calculation

Photo images for the sediment cores were obtained using continuous image photographic equipment with 600 dpi. The color reflectance values of photography were calculated using OpenCV in Python (See Ishiwa *et al.*, 2022[20], for more details). We extracted RGB values from the photography and calculated L*, a*, and b* values from RGB variations.

3.4. Description of lithology

The lithological description was made immediately after the core splitting. Key sedimentologic features were described, including lithologies, visible sedimentary structures, color, grain size, biogenic material, and core disturbance. The primary designation for each lithology was determined by the texture of the grains. Textural names were derived from the Shepard grain size distribution (Shepard, 1954[23]).

4. Data Records

The data from this study consists of four files: Core_data.pdf, MSCL_data.xlsx, Color_data.xlsx, and CT-value_data.xlsx. These data have been deposited in the Arctic Data archive System (ADS) (see Data Citation). Here we provide the pdf-formatted catalog for analyzed cores to make their characteristics easily visible, but we can also offer individual CT images upon requests from readers.

5. Technical Validation

The sediment depth control is essential to conduct paleoenvironmental reconstruction. In this study, the lengths of the cores are based on the visual descriptions and photography of the half-split cores. So, we adjusted the CT and MSCL measurement data lengths with those of the visual description and photography by visually matching the images and measurement results.

The whole cores were kept at room temperature before the MSCL measurements because the magnetic susceptibility changes with the temperature.

6. Usage Notes

Before using the data for publication or presentation in any media, please request permission in writing. Inquiries should be added addressed to:

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7. Figures

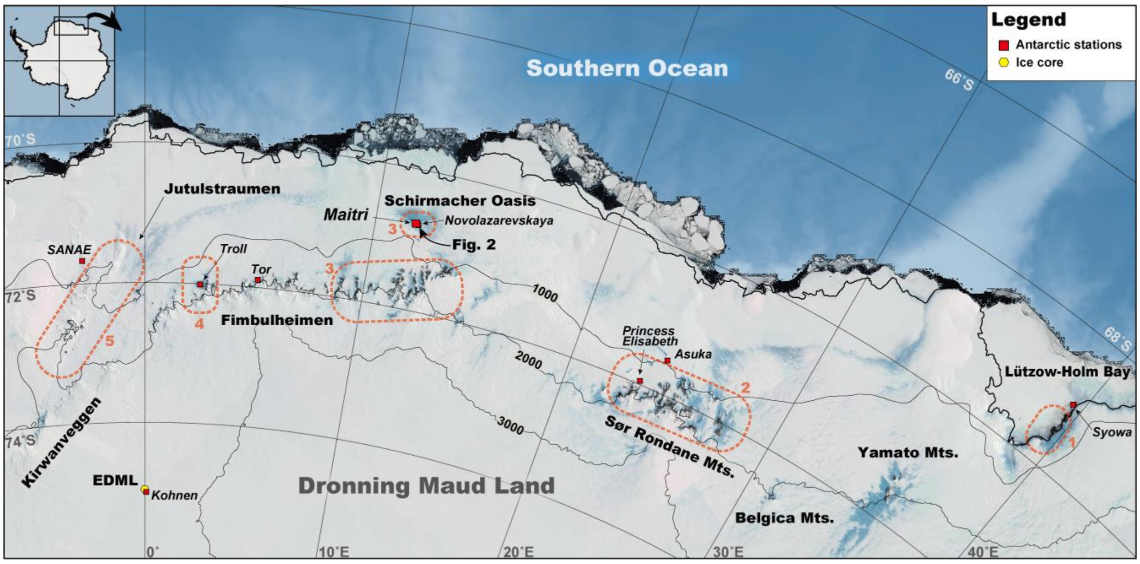

Figure 1. Overview of Dronning Maud Land and location of the study area. The base map is from the Quantarctica GIS package compiled by the Norwegian Polar Institute (Matsuoka *et al.*, 2021[24]). Topographic contours based on Liu *et al.* (2015)[25] are overlain on the Landsat Image of Antarctica (LIMA). The black arrow indicates the location referenced in Figure 2. The orange dashed circles labeled with numbers represent areas where previous research on ice-sheet variability, based on surface exposure dating, has been conducted: 1. Kawamata *et al.*, (2020)[5], Yamane *et al.* (2011)[11], 2. Akçar *et al.* (2020)[26], Matsuoka *et al.* (2006)[27], Moriwaki *et al.* (1992)[28], Nishiizumi *et al.* (1991[29]; 1998[30]), Suganuma *et al.* (2014)[9], 3. Altmaier *et al.* (2010)[2], Strub *et al.* (2015)[31], 4. Suganuma *et al.* (2022)[10], 5. Anderson *et al.* (2020)[3].

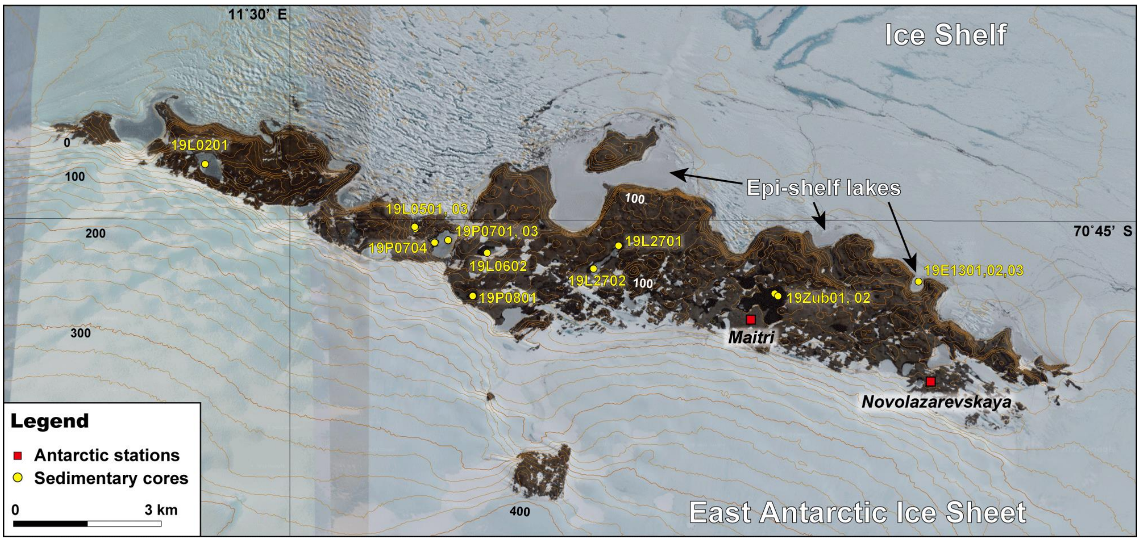

Figure 2. Overview of the Schirmacher Oasis. Red squares and yellow circles correspond to Antarctic stations and sedimentary cores, respectively.

8. Tables

Table 1. All core information.

Name of core	Name of lake	Date of collection	Latitude (S°)	Longtitude (E°)	Water depth (m)	Section (#)	Core length (cm)	Core catcher length (cm)
19E1301	Lake E13	2019.11.18	70.76044	11.81389	39.8	1	32.0	-
						2	146.0	a few
19E1302	Lake E13	2019.11.19	70.76044	11.81392	40.3	1	135.5	-
19E1303	Lake E13	2019.11.21	70.76044	11.81400	40.6	1	99.5	-
						2	148.5	-
19Zub01	Lake Zub	2019.11.08	70.76244	11.74211	6.5	1	28.0	15.0
19Zub02	Lake Zub	2019.11.08	70.76278	11.74383	6.1	1	87.0	15.0
19L0201	Lake L02	2019.11.20	70.74111	11.45744	27.4	1	29.0	-
						2	147.5	11.0
19L0501	Lake L05	2019.11.11	70.75153	11.56211	7.6	1	38.0	8.5
19L0503	Lake L05	2019.11.12	70.75181	11.56236	7.6	1	60.0	-
						2	146.5	15.0
19L0602	Lake L06	2019.11.14	70.75575	11.59825	6.3	1	139.0	-
						2	147.0	a few
19L2701	Long Lake	2019.11.15	70.75464	11.66403	6.3	1	17.0	17.5
19L2702	Long Lake	2019.11.15	70.75839	11.65150	6.3	1	119.0	-
19P0701	Lake P07	2019.11.09	70.75375	11.57881	15.5	1	46.5	15.0
19P0703	Lake P07	2019.11.11	70.75372	11.57881	16.9	1	29.5	10.5
19P0704	Lake P07	2019.11.14	70.75414	11.57081	17.4	1	85.0	15.0
19P0801	Lake P08	2019.11.20	70.76286	11.59106	8.6	1	104.0	a few

Author contributions

The SONIC expedition was designed by an international collaboration between NIPR (PI: Y. Suganuma) and NCPOR (PI: R. Mohan). Sediment cores are obtained by SONIC project members (Y. Suganuma, K. Katsuki, H. Kaneda, B.S. Mahesh, A.K. Warrier). All analyses in MaCRI were carried out by Y. Suganuma, K. Katsuki, T. Ishiwa, and H. Kaneda. All co-authors contributed to improving the manuscript.

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Data Citations

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