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7 Deep sea sediments of the Arctic Central Basin: A potential sink for microplastics

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20 Abstract

21 Deep sea sediments have in the past decade emerged as a potential sink for microplastics in the 22 marine environment. The discovery of microplastics in various environmental compartments of 23 the Arctic Central Basin (ACB) suggested that these contaminants were potentially being 24 transported to the deep-sea realm of this oceanic basin. For the first time, the present study 25 conducted a preliminary assessment to determine whether microplastics were present in surficial 26 sediments from the ACB. Gravity and piston corers were used to retrieve sediments from depths 27 of 855 – 4353 m at 11 sites in the ACB during the Arctic Ocean 2016 (AO16) expedition. Surficial sediments from the various cores were subjected to density flotation with sodium tungstate 28 dihydrate solution (Na₂WO₄.2H₂O, density 1.4 g cm⁻³). Potential microplastics were isolated and 29 30 analysed by Fourier Transform Infrared (FT-IR) spectroscopy. Of the surficial samples, 7 of the 11 samples contained synthetic polymers which included polyester (n = 3), polystyrene (n = 2), 31

polyacrylonitrile (n = 1), polypropylene (n = 1), polyvinyl chloride (n = 1) and polyamide (n = 1). 32 Fibres (n = 5) and fragments (n = 4) were recorded in the samples. In order to avoid mis-33 interpretation, these findings must be taken in the context that (i) sampling equipment did not 34 guarantee retrieval of undisturbed surficial sediments, (ii) low sample volumes were analysed (~ 35 10 g per site), (iii) replicate sediment samples per site was not possible, (iv) no air contamination 36 checks were included during sampling and, (v) particles <100 µm were automatically excluded 37 from analysis. While the present study provides some preliminary indication that microplastics 38 may be accumulating in the deep-sea realm of the ACB, further work is necessary to assess 39 microplastic abundance, distribution and composition in surficial sediments of the ACB. 40

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42 Keywords: Microplastic, Marine debris, Arctic Ocean, Sediment, Deep Sea

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45 **1. Introduction**

Microplastics are pervasive, persistent contaminants in the world's oceans that warrant concern 46 47 due to the potential threat they pose to marine organisms. Traditionally, microplastic sampling has been conducted in surface and near-surface waters due to the presumption that the majority of 48 49 microplastics would be present in that layer of the water column. However, when plastic production and projected plastic input to the ocean was considered, there was an evident mismatch 50 51 between reported and expected plastic concentrations in surface oceanic waters (Cózar et al. 2014; Eriksen et al. 2014). It was therefore apparent that apart from surface waters, microplastics were 52 53 present in various environmental compartments in the world's oceans (water column, sea ice, sediments, biota) and that some of these potentially functioned as sinks (Obbard et al. 2014; 54 55 Woodall et al. 2014). Deep sea sediments have recently been identified as a potential sink for microplastics (Woodall et al. 2014; Bergmann et al. 2017). To date, only a few studies have 56 reported on microplastics in deep sea sediments in various oceanic basins (Van Cauwenberghe et 57 58 al. 2013; Woodall et al. 2014; Fischer et al. 2015; Bergmann et al. 2017). Despite the fact that each of these studies employed different sampling equipment, extraction techniques and reported 59 60 microplastic abundance in different units, the consensus was that microplastics have made it to the deep-sea and that they are pervasive in its sediments. Presently, uncertainty still exists regarding 61

the exact mechanisms that are responsible for the vertical transport of microplastics out of surfaceoceanic waters and into deep sea sediments.

64

The Arctic Ocean, though one of the most remote oceanic basins in the world, has been subject to 65 the entry of plastic debris into its ecosystem. It has been suggested that this plastic debris, in 66 particular microplastics, could have entered the Arctic ecosystem via a combination of (i) long-67 range transport processes, e.g. via oceanic currents (Zarfl and Matthies 2010; van Sebille et al. 68 2012), biotransport (Mallory 2008; Provencher et al. 2012) and riverine input (Obbard et al. 2014) 69 and, (ii) local anthropogenic activities, e.g. shipping (Tekmann et al. 2017). Specifically, 70 microplastics were discovered in the surface/sub-surface waters and sediments (Lusher et al. 2015; 71 Bergmann et al. 2017; Cózar et al. 2017; Mu et al. 2019) of the Arctic. Further north, in the Arctic 72 73 Central Basin (ACB), microplastics were recorded in sea ice, biota, such as juvenile polar cod (Boreogadus saida) and benthic organisms, and sub-surface waters (Obbard et al. 2014; Kanhai et 74 al. 2018; Kuhn et al. 2018; Peeken et al. 2018; Fang et al. 2018). The fact that microplastics have 75 76 been reported in the various water layers of the ACB, in particular its deep waters, suggests that 77 these particles are pervasive in the water column and that they are being transported out of its surface waters (Kanhai et al. 2018). It was therefore hypothesized that microplastics would be 78 79 present in deep sea sediments in the ACB. To our knowledge, the present study sought for the first time to determine whether microplastics were present in surficial sediments of the Arctic Central 80 81 Basin (ACB) and to establish whether the deep sea in this oceanic basin is possibly acting as a sink for microplastics. 82

83

84 **2. Material and methods**

85 The Arctic Ocean, the world's smallest ocean, is comprised of a deep central basin surrounded by 86 extensive continental shelves. The bathymetry of the Arctic Ocean is such that the Lomonosov Ridge divides the central basin into the Canadian (Amerasian) and Eurasian sub-basins (Jakobsson 87 et al. 2004). Within each of the sub-basins, there are further divisions as well as the existence of 88 Abyssal Plains (APs) which are deep water areas of low relief. In the Amerasian basin, the Alpha-89 90 Mendeleev Ridge separates the Canada Basin (with its Canadian AP) and the Makarov Basin (with its Fletcher AP) while in the Eurasian basin, the Gakkel Ridge separates the Amundsen Basin (with 91 92 its Pole AP) and the Nansen Basin (with its Barents AP), (Jakobsson et al. 2004).

94	This study was conducted onboard the Swedish icebreaker Oden between August 8th to September
95	19th 2016 during the Arctic Ocean 2016 expedition. During the transit of 4943 nautical miles,
96	sediments were retrieved using a gravity corer or a piston corer with an associated trigger weight
97	corer. Cores from 11 stations were sampled for microplastics (Supplementary Table 1, Figure 1).









102 [Figure 1a generated using Ocean Data View (ODV) Version 4.7.10 (Schlitzer 2017); Figure 1b

103 generated using R version 3.4.4 (R Core Team 2018)]

104

Cores were split, wrapped in plastic film (polyethylene) and transported to the laboratory where 105 106 they were processed prior to sampling for microplastics. Processing usually involved (i) scraping the core half (with a polypropylene scraper) to remove liner fragments and sediment disturbed 107 108 during core splitting and, (ii) visually describing the lithostratigraphic properties. Sheer strength measurements, sediment pH and samples for paleomagnetic measurements were taken prior to 109 110 microplastic sampling for four of the eleven cores (gravity and piston cores). Approximately 10 cm^3 of sediment was sampled from the top 2 cm of the working half of each core using a scoop 111 (polypropylene). Sediment samples were placed into clean, labelled plastic bags (polyethylene) 112 and stored in a freezer (-20°C). 113

114

115 Although it is acknowledged that such a low volume of sediment may not be representative of sediments at individual sampling stations, the sampling technique used in the present study, i.e. 116 coring, limited the volume of sediment that was available per site. Precautions taken onboard the 117 ship to limit cross-contamination included (i) minimal exposure of the sediment samples to the 118 119 atmosphere, (ii) samples collected/stored in new materials (scoops, bags) and, (iii) sampling conducted by one individual. A record was also kept of all plastic materials that came into contact 120 121 with the sample during collection and processing. One limitation was that no air contamination check was included during sediment sampling onboard the vessel. 122

123

124 In the laboratory, sediments were defrosted, transferred into clean covered aluminium foil trays and oven dried at 60°C for approximately 96 hours. Approximately 10 g of oven-dried sediment 125 was weighed and placed into a pre-cleaned glass jar. 105 mL of sodium tungstate dihydrate 126 (Na₂WO₄.2H₂O, 40 % w/v, density 1.4 g cm⁻³), as recommended by Frias et al. (2018) and Pagter 127 et al. (2018), was added to each glass jar, the mixture was shaken for approximately 1 minute and 128 the sediments were allowed to settle. From each sample jar, the overlying sodium tungstate 129 dihydrate solution was removed using a pipette and filtered under vacuum onto glass microfiber 130 paper (GF/C), Whatman 47 mm, pore size 1.2 µm, using a Buchner funnel and an Erlenmeyer 131 132 flask. Minimal volumes of ultrapure water (< 2 mL) were used to wash down the sides of the glass jars with the sediments. Introducing water into the remaining extraction solution can lead to a 133 134 change in the density of the solution and thus this was minimised. Ultrapure water was also used

to wash the pipette and sides of the Buchner funnel. Filter papers for the samples were placed into clean petri dishes and stored until analysis. Potential contamination was evaluated by using (i) air contamination checks-clean petri dishes with filter paper (n = 2) were exposed to the air during sample processing and, (ii) method blanks-jars devoid of sediment (n = 2) were processed in the same manner as actual samples. Measures taken to prevent contamination in the laboratory included (i) wearing lab coats and gloves during sample processing and, (ii) washing all glass jars used during sample processing with a 6 % nitric acid solution and Ultra-pure water.

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Filter papers were visually examined under a dissecting microscope (Olympus SZX10) equipped 143 with a polariser and camera (Q Imaging Retiga 2000R). Potential microplastics were isolated and 144 processed (photographed and length measurements taken) prior to transferring to a clean filter 145 146 paper in a labelled petri dish (Kanhai et al. 2017). Due to the difficulties that arise when handling particles $< 100 \,\mu$ m, such particles were automatically excluded for any analysis. All potential 147 microplastics and any plastic material that was in direct contact with the samples either during 148 sampling or laboratory processing were analysed by Fourier transform infrared (FT-IR) 149 150 spectroscopy on a Bruker Vertex 70 Infrared Spectrometer coupled to a Hyperion 1000 microscope (Kanhai et al. 2017). Samples which produced spectra with a match < 60 % were automatically 151 rejected while those which produced a match of > 70 % were accepted. All spectra with matches 152 > 60 % were individually examined to ensure that there was clear evidence of peaks from the 153 154 sample corresponding to known peaks of standard polymers.

155

156 **3. Results**

In the present study, the following plastic materials made direct contact with the sediment samples 157 158 either during collection or processing (i) plastic film – low density polyethylene (LDPE), (ii) core liner – polyvinyl chloride (PVC) or polycarbonate (PC), (iii) scraper - polypropylene (PP), (iv) 159 160 sediment collection scoop - polypropylene (PP) and, (v) sample bag - low density polyethylene 161 (LDPE). In the surficial sediment samples, no polyethylene particles were recovered. However, in two instances, synthetic polymers from surficial sediments matched plastic materials used during 162 163 sample processing but were not eliminated since they were of different colours than the materials used. This was so for 2 particles in sediment core 4 (single PVC fragment, different colour from 164 liner) and sediment core 7 (polypropylene fragment, different colour from collection 165

166 scoop/scraper). To assess whether synthetic polymers were introduced during laboratory 167 processing of the samples, air contamination checks (ACs), (n = 2), and method blanks (MBs), (n 168 = 2), were included. No synthetic polymers were found in the air contamination blanks. However, 169 a total of three fibres were found in the two method blanks (MB1 – blue polyester fibre, 1.28 mm; 170 MB2 – blue polyester fibre, 0.49 mm and red polyester fibre, 0.53 mm). All samples were blank 171 corrected such that if any blue or red polyester fibres were found in the sediment samples, they 172 were removed from the final results.

173

Based on visual identification, fifteen particles from the sediment samples were isolated and 174 subjected to FTIR spectroscopy. Of these, four were natural cellulosic fibres. The remaining eleven 175 were identified as synthetic polymers with one macroplastic (> 5 mm) and ten microplastics (< 5176 mm). After blank correction of the samples, there were a total of nine microplastics (<5 mm), 177 (Supplementary Table 2). Synthetic polymers detected in the sediments included polyester (n = 3), 178 polystyrene (n = 2), polyacrylonitrile (n = 1), polyamide (n = 1), polypropylene (n = 1) and 179 polyvinyl chloride (n = 1). Both fibres (n = 5) and fragments (n = 4) were present in the samples. 180 181 In terms of colour, most of the synthetic polymers were transparent (n = 5) with the remainder black (n = 1), brown (n = 1), white (n = 1) and blue (n = 1). With respect to length, most (n = 5)182 were < 1 mm, 3 were between 1 - 2 mm and 1 was > 2 mm. Of the surficial sediment samples 183 analysed from the Arctic Central Basin (ACB), 7 of the 11 samples contained between 1 - 2184 185 synthetic polymers (Figure 1b).

186

187 **4. Discussion**

Elucidation of the transport and fate of microplastics in the marine environment is a critical step 188 189 towards assessing the threat that these contaminants potentially pose to organisms inhabiting different compartments of an ecosystem. In the Arctic Central Basin (ACB), only a few studies 190 191 have reported on microplastic presence in the sea ice, biota and water column (Obbard et al. 2014; Kuhn et al. 2018; Kanhai et al. 2018; Peeken et al. 2018). Based on these studies, the key 192 193 suggestions regarding microplastics in this oceanic basin are that (i) sea ice acts as a sink and 194 means of transport for microplastics, and (ii) the pervasiveness of microplastics in the various water layers of the ACB indicates that there is vertical transport of microplastics out of surface 195 196 waters into deeper waters (Obbard et al. 2014; Kanhai et al. 2018; Peeken et al. 2018). In context,

197 the findings of the present study expand the knowledge base about microplastics in the Arctic Ocean by providing preliminary information that suggests microplastics are present in surficial 198 199 sediments of the Arctic Central Basin and that within this oceanic basin the sediment compartment is potentially acting as one of the sinks for microplastics. Microplastic presence on the seafloor of 200 201 the ACB lends credence to the suggestion that there is vertical transport of microplastics within the water column. Laboratory and field studies have shown that marine organisms, such as 202 203 zooplankton, larvaceans and other pelagic filter feeders, which are capable of ingesting microplastics and egesting them in their faecal pellets and discarded houses (as in the case of the 204 larvaceans), could contribute to the vertical flux of microplastics in the water column when their 205 206 waste products sink (Cole et al. 2016; Katija et al. 2017). The incorporation of microplastics into marine aggregates and the biofouling of microplastics are other processes which may influence the 207 vertical transport of these particles in the water column (Long et al., 2015; Fazey and Ryan 2016). 208 209

The presence of microplastics in sediments of the Arctic Central Basin implies that interactions 210 between these particles and deep-sea organisms that inhabit or depend upon this environmental 211 212 phase is plausible. Although the Arctic Ocean has generally been regarded as oligotrophic, the fact remains that marine organisms do inhabit its' deep-water environment with the most speciose 213 214 groups being arthropods, foraminiferans, annelids and nematodes (Bodil et al. 2011). Depending on the foraging behaviours and feeding habits of deep-sea benthos in the ACB, the possibility 215 216 exists that some of them may be interacting with microplastics in the sediment phase. Recently, Fang et al. (2018) reported that microplastics were discovered in 11 different benthic species that 217 were recovered from depths of 35 - 151 m in the Bering-Chukchi Sea shelves. Fibres were the 218 predominant type of microplastics found in the organisms with synthetic polymers including 219 220 polyamide, polyethylene, polyester and cellophane (Fang et al. 2018). Microplastics were also discovered in 3 different phyla (Echinodermata, Arthropoda, Cnidaria) of deep sea organisms 221 222 recovered from depths of 334 - 1783 m in the equatorial mid-Atlantic and SW Indian Ocean (Taylor et al. 2016). Although the presence of a contaminant in the marine environment does not 223 directly imply harm, laboratory experiments have indicated that benthic organisms exposed to 224 225 microplastics in sediments may be negatively impacted. For example, Wright et al. (2013) reported that exposure of the deposit-feeding marine polychaete worm (Arenicola marina) to unplasticised 226

polyvinyl chloride (UPVC) led to a depletion in energy reserves of the worms which could have
been caused by reduced feeding, longer gut residence time of ingested matter and inflammation.

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230 The present study confirmed via FT-IR spectroscopy that polyesters were recovered from surficial sediments of the ACB. Such findings are corroborated by previous studies which investigated other 231 environmental phases in this oceanic basin. Obbard et al. (2014) reported that of the synthetic 232 233 polymers found in sea ice, the majority were polyester (21 %). Kanhai et al. (2018) similarly found that of the synthetic particles present in the sub-surface waters, polyesters (74 - 78 %) were also 234 predominant. Upon melting, sea ice can act as a local source of microplastics to the water column 235 (Obbard et al. 2014; Peeken et al. 2018). Synthetic polymers that are present in surface waters of 236 this oceanic basin could then be subject to vertical transport, persist in the water column as 237 238 evidenced by Kanhai et al. (2018) and at some stage a fraction of these particles could end up in the sediment phase. Of interest is the fact that the present study found low density polymers such 239 240 as polypropylene and polystyrene fragments in the sediments of the ACB. Based on the inherent densities of the virgin resins, such particles are unlikely candidates for the sediment phase in that 241 242 they are positively buoyant and are expected to float. However, this suggests that there are mechanisms operating within the ACB that could be affecting the density of these particles and in 243 244 effect causing them to end up in the sediment phase. Long et al. (2015) showed that under laboratory conditions marine aggregates of various algal species (Chaetoceros neogracile, 245 246 Rhodomonas salina) were capable of incorporating and concentrating polystyrene microbeads which in turn led to an increase in their sinking rates. Such mechanisms can potentially explain 247 248 the presence of low-density polymers in surficial sediments of the ACB. Of note is the fact that the present study is not the first to report the presence of low density polymers in deep sea 249 250 sediments since polyethylene and polypropylene particles were found in surficial sediments from 251 the Fram Strait (Bergmann et al. 2017).

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Within the last decade, deep-sea sediments were for the first time identified as a potential sink for microplastics with four studies reporting on the issue in various oceanic basins (Supplementary Table 3). Comparison between these studies is particularly challenging and not straightforward due to the fact that each used different sampling equipment, extraction techniques and reported microplastic abundance/concentration in different units (Supplementary Table 3). Microplastic 258 abundance in surficial sediments of the ACB was estimated to range between 0-200 microplastics kg⁻¹ dry sediment based on the findings of the present study. However, it is unlikely that these 259 260 estimates are reflective of the situation in the ACB since (i) the equipment used for sample retrieval (gravity and piston corers) may have led to the collection of disturbed surficial sediment samples, 261 (ii) low sample volumes (~ 10 g per site) were used to assess microplastic abundance, (iii) the 262 density of the extraction solution was only 1.4 g cm⁻³ and thus could have excluded high density 263 264 polymers, (iv) replicate sediment samples per site was not possible, (v) particles $< 100 \,\mu m$ were excluded by virtue of the procedure used to identify/isolate potential microplastics. During the 265 AO16 expedition, gravity and piston corers were used to retrieve sediments from several metres 266 267 in depth from the ACB. Among the corers, gravity and piston corers are not guaranteed to retrieve undisturbed surficial sediment samples due to the shock wave that they generate during descent 268 (Gallmetzer et al. 2016). It is therefore likely that any shock waves generated by the corers used 269 in the present study may have triggered a resuspension of surficial material (sediments and 270 microplastics) into the water column leading to an overall reduction and subsequent 271 272 underestimation of microplastic abundance in the samples. When sampling surficial marine 273 sediments, equipment such as box and multi-corers may be more suitable for the recovery of undisturbed surficial sediment samples (Georgiopoulou 2018). Box corers were recommended by 274 275 Frias et al. (2018) due to (i) the minimal impact they have on surface deformation of sediments and, (ii) their ability to maintain sediment integrity during sampling. 276

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Furthermore, due to the heterogenous nature of sediments, it is unlikely that the low sample 278 volumes (~ 10 g of sediment) used in the study were reflective of the situation at the respective 279 sites. Future studies should ensure that replicate samples are collected per site. Multi-corers may 280 281 be particularly useful since they can facilitate the collection of replicate samples in a single deployment. When density separation is used to extract microplastics from sediment samples, the 282 283 density of the extraction solution is important in determining which synthetic polymers are extracted from the samples. Although sodium tungstate dihydrate (density 1.4 g cm⁻³) was used in 284 285 the present study based on a safety-price index assessment (i.e. cost and health hazard), the density 286 of the solution could have led to the exclusion of some high-density polymers (Frias et al. 2018). Loder and Gerdts (2015) recommended the use of zinc chloride based on its cost effectiveness and 287 its higher density of 1.8 g cm⁻³. However, the health hazard is high for this particular extraction 288

289 solution (Frias et al. 2018). Finally, the methods employed by investigators for the isolation and 290 identification of microplastics influences the final reported microplastic abundance. In the present 291 study, particles < 100 µm were automatically excluded from analysis. However, it must be noted 292 that at the Atlantic gateway to the Arctic Ocean i.e. the Fram Strait, Bergmann et al. (2017) 293 reported that the majority (80 %) of microplastics in surficial sediments from that area were < 25μm. Bergmann et al. (2017) used a combination of ATR-FTIR spectroscopy as well as a μFTIR 294 295 microscope equipped with a focal plane array detector to detect microplastics. It is therefore likely that if similar analytical techniques were employed to analyse the surficial sediment samples of 296 the present study, higher microplastic abundances may have been reported, especially in the cases 297 298 where zero microplastics were reported in certain samples.

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300 Another limitation of the present study is the non-inclusion of an air contamination check during sampling onboard the vessel. Such a check would have been necessary to rule out airborne 301 contamination during sampling. Since this was not done, the possibility exists that one or more of 302 the particles reported as present in the surficial sediments of the ACB could have been introduced 303 304 into the samples as a result of airborne contamination. The findings of the present study should therefore be regarded as preliminary and be used as a justification for future studies which can 305 306 provide more comprehensive assessments of microplastics in deep-sea sediments of the Arctic Central Basin. 307

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309 5.0 Conclusion

310 To our knowledge, this is the first study to present preliminary information regarding microplastics in surficial sediments of the Arctic Central Basin (ACB). The potential discovery of these particles 311 312 in the sediment phase of this seemingly remote oceanic basin emphasizes the pervasiveness of microplastics in the marine environment. The possible presence of microplastics, specifically low-313 density polymers such as polypropylene (PP) and polystyrene (PS), in the sediment phase of the 314 315 ACB suggests that there are mechanisms operating within this oceanic basin that are potentially affecting the density of microplastics and that are potentially driving the vertical transport of these 316 317 particles through the water column. Microplastics that are present in sediments of the ACB are likely to interact with organisms inhabiting or depending upon this environmental phase. At 318 319 present, whether those interactions are occurring with benthic organisms within the ACB and the

320 consequences of those interactions to individual organisms and the ecosystem services that they 321 perform remains uncertain. Due to the numerous limitations of the present study, the findings 322 should not be taken as conclusive regarding the status of microplastics in the surficial sediments 323 of the ACB but instead be used as a foundation for future work seeking to quantify microplastic 324 abundance, distribution and composition in surficial sediments of the Arctic Ocean.

325

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335

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343

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Sample No. ^a	Core ID	Latitude	Longitude	Location in the ACB	Water Depth (m)	Core Type ^b
1	AO16-1-GC1	80.5532	8.0520	Yermak Plateau	855	GC
2	AO16-2-PC1	88.5022	-6.6195	Amundsen Basin	4353	PC
3	AO16-3-TWC1	89.2530	-66.6097	Foot of Lomonosov Ridge	3777	TWC
4	AO16-4-TWC1	88.5290	-128.5048	Marvin Spur	3936	TWC
5	AO16-5-TWC1	89.0780	-130.5470	Crest of Lomonosov Ridge	1253	TWC
6	AO16-7-PC1	88.6332	-121.4477	Marvin Spur	3941	PC
7	AO16-8-GC1	86.7795	-140.6433	Alpha Ridge	2620	GC
8	AO16-9-TWC1	85.9557	-148.3258	Alpha Ridge	2212	TWC
9	AO16-10-TWC1	82.3980	-141.2450	Nautilus Basin	2872	TWC
10	AO16-11-TWC1	86.0993	173.1877	Makarov Basin	3066	TWC
11	AO16-12-TWC1	87.8577	136.9875	Crest of Lomonosov Ridge	1269	TWC

Supplementary Table 1: Site-specific information for sediment cores sampled for microplastics in the Arctic Central Basin

^aSample numbers correspond to those on Figure 1a; ^bGC (Gravity core); PC (Piston core); TWC (Trigger weight core)

Supplementary Information related to particle size and organic carbon content analysis

Method: For particle size analysis, approximately 0.1 g of wet sediment from each sediment core was transferred to a test tube. To this, 3 mL of sodium metaphosphate solution (10%) was added and the total volume brought to 10 mL using de-ionized water. The contents of the tube were stirred, ultrasonicated for approximately 30 seconds to facilitate disaggregation and then transferred to the Hydro LV wet dispersion unit of a Mastersizer 3000 laser diffraction particle size analyser (Malvern Instruments, UK). De-ionized water was used to bring the final volume in the wet dispersion unit to 600 mL prior to analysis. The particle size of surficial sediments from each core was based on the analysis of three sub-samples. Following Pagter et al. (2018), approximately 3 g of dried sediment (105 °C, 4 h) from each sample was placed into a furnace at 450 °C for 6 hours in order to estimate the organic content of the sediment samples based on loss on ignition. Grain size composition of the surficial sediment data was conducted using Gradistat Version 8 (Blott 2010).

Results: Regarding the particle size composition of the sediments, all sampled sites had a predominance of fine-grained sediments where the percentage of silt (59 - 87 %) > clay (10 - 24 %) > sand (1 - 23 %) > gravel (0 - 0.2 %), (Supplementary Table 1). Organic content of the surficial sediment samples ranged between 2.3 - 4.6 % (Supplementary Table 1).

Reference:

Blott, S., 2010. Gradistat Version 8: A grain size distribution and statistics package for the analysis of unconsolidated sediments by sieving or laser granulometer. Kenneth Pye Associates Limited, Berkshire, UK.

	Sample Number										
	1	2	3	4	5	6	7	8	9	10	11
Grain size composition (%)											
Total Gravel (%)	0.0	0.0	0.0	0.1	0.0	0.1	0.2	0.0	0.0	0.1	0.0
Total Sand (%)	3.3	5.2	1.2	7.5	12.4	15.2	17.5	16.4	22.6	10.2	7.5
Total Silt (%)	86.9	73.6	76.4	68.4	70.5	65.6	63.4	63.0	59.3	69.8	73.7
Total Clay (%)	9.8	21.2	22.5	24.1	17.1	19.2	18.9	20.5	18.0	19.8	18.7
Organic content (%)	4.6	4.0	4.4	3.5	3.3	2.6	3.4	3.6	2.6	2.3	2.8
Polymer Type (n)											
Polyacrylonitrile (PAN)			1								
Polyamide (PA)					1						
Polyester (PES)		2									1
Polypropylene (PP)							1				
Polystyrene (PS)							1	1			
Polyvinyl chloride (PVC)				1							
Total number of synthetic polymers	0	2	1	1	1	0	2	1	0	0	1
Size (mm); Type (Fi-fibre; Fr-fragment)		1.84 (Fi)	0.47 (Fi)	0.91 (Fr)	3.58		0.88 (Fr)	0.45			1.03 (Fr)
of microplastics		1.38 (Fi)			(Fi)		0.54 (Fr)	(Fr)			
Microplastic concentration											
Mass of dry sediment used (g)	10.02	10.12	7.86	9.83	10.20	10.89	9.31	10.09	10.07	10.36	4.54
Microplastic concentration (items kg ⁻¹)	0	198	127	102	98	0	215	99	99	97	220

Supplementary Table 2: Synthetic polymer composition and grain sizes of surficial sediments in the Arctic Central Basin

Location	Depth (m)	Sampling Equipment	Extraction Method	Microplastic abundance	Synthetic polymers	Study	
Porcupine Abyssal Plain Nile Deep Sea Fan Atlantic Sector of the Southern Ocean	1176 – 4843	Multicorer	Density flotation, NaI (1.6 g cm ⁻³)	0.5 particles cm ⁻³ (average, $n = 11$) 1 particle cm ⁻³ (max)	No data	Van Cauwenberghe et al. (2013)	
Subpolar North Atlantic Ocean NE Atlantic Ocean Mediterranean Sea SW Indian Ocean	300 - 3500	Megacorers Boxcorers	Density flotation, NaCl, Ludox- TM 40 extraction	1.4 - 40 pieces per 50 ml (mean ± s.e., 13.4 ± 3.5)	PA, PES, Acrylic Rayon	Woodall et al. (2014)	
Kuril-Kamchatka Trench, NW Pacific	4869 - 5768	Box corer	Sieve- washing of sediments	60 - 2020 pieces m ⁻²	No data	Fischer et al. (2015)	
HAUSGARTEN observatory, Fram Strait	2340 - 5570	Multiple corer	Density separation, zinc chloride (1.8 g cm ⁻³)	42 – 6595 microplastics kg ⁻¹ dry sediment	18 polymer types detected. Majority: PE, PA, PP	Bergmann et al. (2017)	
Arctic Central Basin	855 - 4353	Gravity and piston corer	Density separation, sodium tungstate dihydrate (1.4 g cm ⁻³)	0 - 200 microplastics kg ⁻¹ dry sediment	PA, PAN, PES, PP, PS, PVC	This study	

Supplementary Table 3: Microplastics in deep sea sediments of various oceanic basins

PA-Polyamide, PAN-Polyacrylonitrile, PES-Polyester, PP-Polypropylene, PS-Polystyrene, PVC-Polyvinyl chloride