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Systematic identification of microplastics in abyssal and hadal sediments of the Kuril Kamchatka trench.

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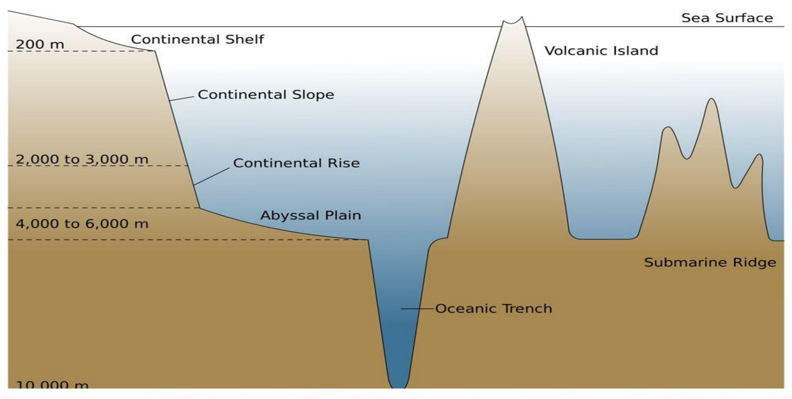
Abstract number: 337476

introduction

The occurrence of microplastics throughout marine environments worldwide, from pelagic to benthic habitats, has become serious cause for concern. Hadal zones were recently described as the "trash bins of the oceans" and ultimate sink for marine plastic debris. The Kuril region covers a substantial area of the North Pacific Ocean and is characterised by high biological productivity, intense marine traffic through the Kuril straits, and anthropogenic activity. Strong tidal currents and eddy activity, as well as the influence of Pacific currents, have the potential for long distance transport and retention of microplastics in this area. The Kuril Kamchatka Trench might accumulate microplastics from the surrounding environments and act as the final sink for high quantities of microplastics



Oceanic trenches:

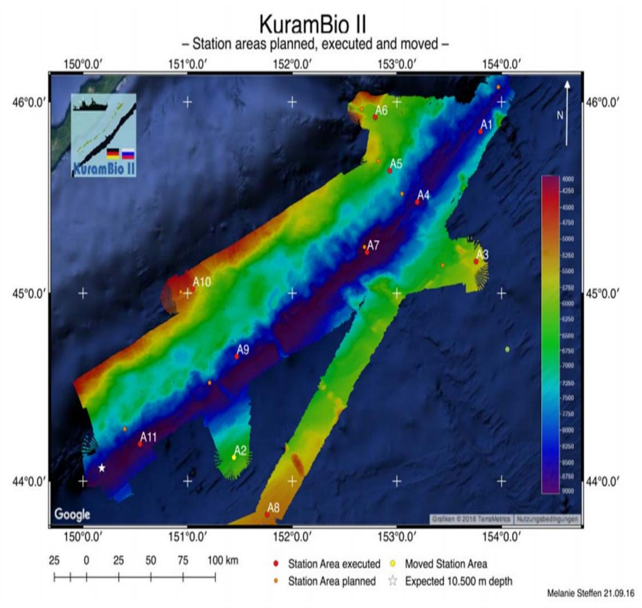
- The deepest environment on our planet (6000-10.989 m).
- Of the 20 major trenches, 17 are found in the Pacific basin.
- Relatively delicate ecosystems.
- Hotspot of biodiversity.

The Kuril Kamchatka trench:

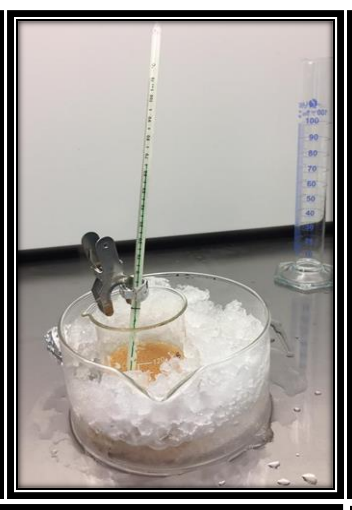
- Located in the North-west Pacific Ocean.
- The trench formed as a result of the subduction zone, which formed in the late Cretaceous.
- The deepest point is at 10.542 m.
- The trench is 2250 km long.
- The Kurile current (Oyashio) and Kuril counter current (Kuroshio), influence this area and may be responsible for long-distance litter transport.

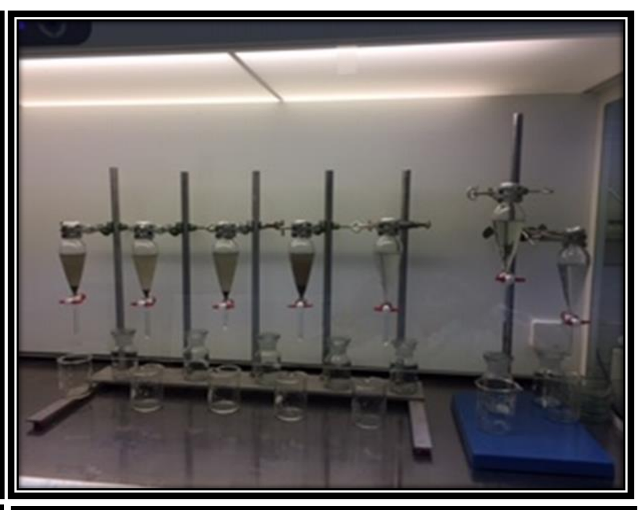
The aim of this study was to quantify the MP present in the deep KKT, to characterise the MP particles by size and polymer type, and to contribute to a further understanding of MP accumulation in deep-sea trenches. To examine the potential inaccuracies of aliquot-based estimations, samples were both aliquot sub-sampling and *in toto* sample analysis were performed on each sample.

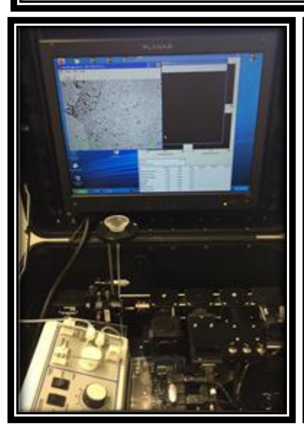
Materials and methods

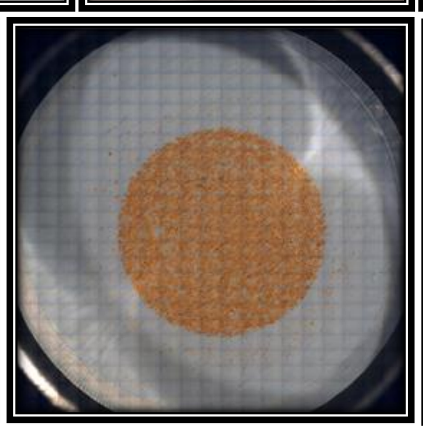


The samples were collected from the KKT (northwest Pacific Ocean) in summer 2016, onboard the RV *Sonne*, during the deep-sea expedition SO-250 KuramBio II, using a Multi-corer (MUC, version: 2011-K2 x100; OKTOPUS GmbH, Kiel, Germany)









A density separation was then performed on each individual sample using a MPSS device (Micro Plastic Sediment Separator, Hydro-Bios Apparatebau GmbH, Kiel). Fenton's treatment was applied to remove organic material. A second density-separation step was performed to remove any remaining inorganic material. FlowCam (Fluid Imaging Technologies, Portable version IV, Scarborough, Maine, US) was used to quantify the particle concentrations in a sub-sample (100 µl) of each of the pre-treated sample solutions. For the chemical identification, quantification and sizing of MPs, a Focal Plane Array-based µ-FT-IR hyperspectral-imaging approach was applied.

Results

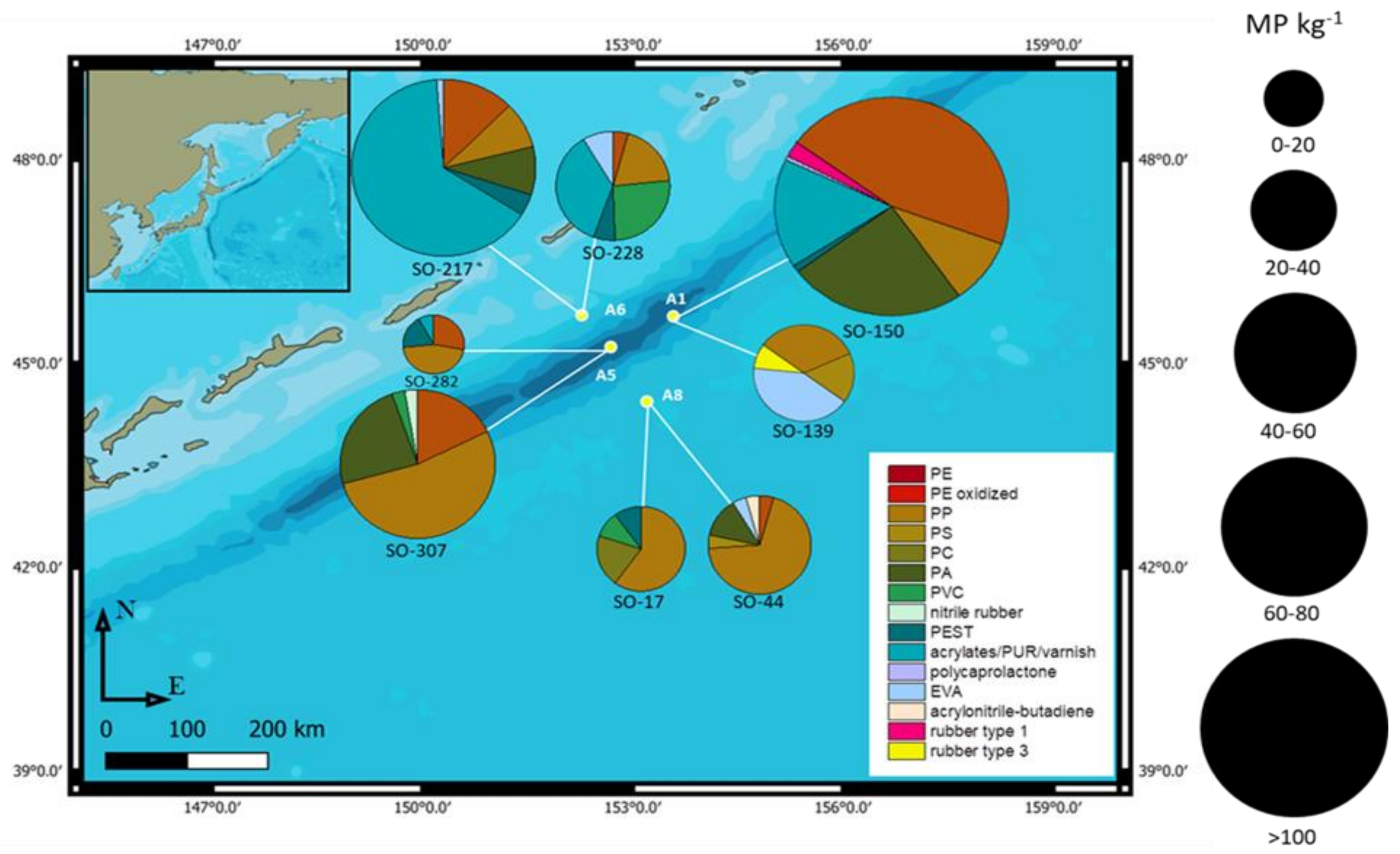


Fig. 1

Geographic distribution of microplastic concentration and relative polymer composition in sediments from the Kuril Kamchatka trench. PE: polyethylene, PP: polypropylene, PS: polystyrene, PC: polycarbonate, PA: polyamide, PVC: polyvinyl chloride, PEST: polyester/polyethylene terephthalate, PUR: polyurethane, EVA: ethylene vinyl acetate.

MP from eight sediment samples, representing four sampling stations in the abyssal and hadal part of the KKT, were successfully extracted and analysed. MP concentrations in the samples ranged from 14 kg^{-1} (SO282) to 209 kg^{-1}(SO150), MP polymer diversity detected ranged from four (SO282) to seven (SO44, SO217 and SO150). In Fig. 1 MP concentration per kg sediment (DW) and relative MP polymer diversity detected in the sampling stations are displayed, with the pie-charts' sizes depicting MP concentration for each corresponding sample site.

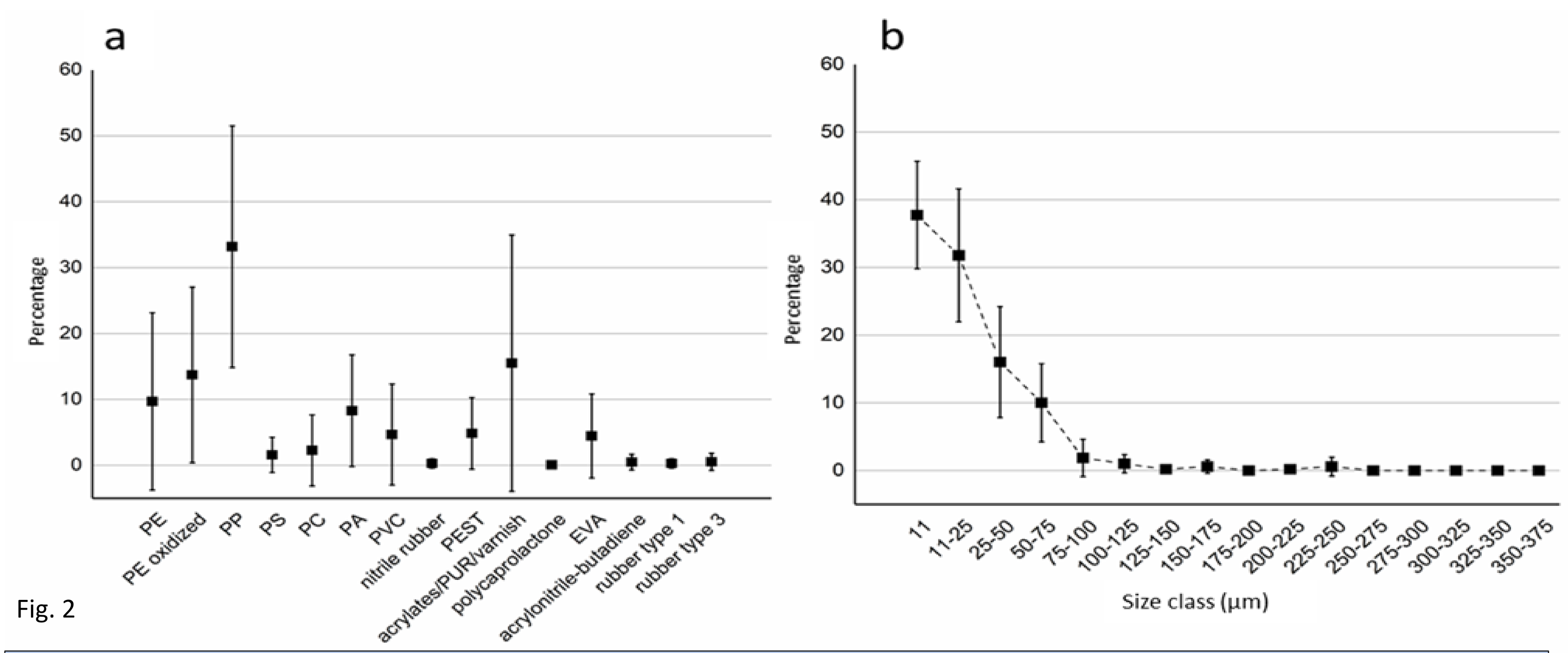


Fig. 2

Mean percentage of each polymer type in all sediment samples (black square) PE: polyethylene, PP: polypropylene, PS: polystyrene, PC: polycarbonate, PA: polyamide, PVC: polyvinyl chloride, PEST: polyester/polyethylene terephthalate, PUR: polyurethane, EVA: ethylene vinyl acetate. Whiskers show the 95 % confidence interval. (b) Mean percentage of each size class in µm for all sediment samples (squares). Whiskers show the 95 % confidence interval.

Ten different MP polymer types contributed on average between 33.2 % (PP) and 1.6 % (PS) to the relative abundance of polymer types over all samples while five polymer types contributed less than 1 % (in descending order): acrylonitrile-butadiene, rubber type 3, nitrile rubber, rubber type 3 and polycaprolactone

All MP particles were smaller 375 µm (Fig. 2b.) with 99 % smaller than 125 µm in size, and 71.7 % smaller than 25 µm

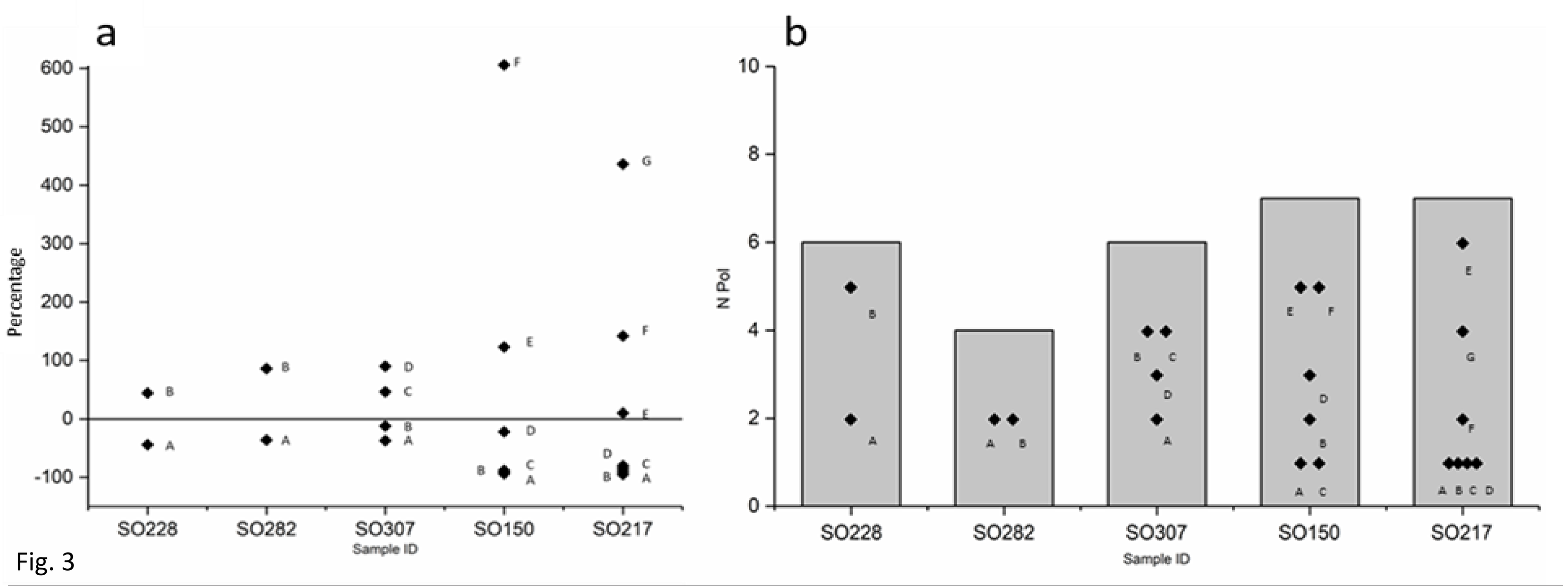


Fig. 3

(a) Variation of the estimated Microplastic concentration per kg sediment (dry weight) in the aliquots from the microplastic concentration in the sample, reported in relative presentence. (b) Polymer diversity in samples. Grey bars depict microplastic polymers in the sample. Symbols depict plastic polymers in aliquot.

By comparing extrapolated sample aliquots with *in toto* results, it was shown that aliquot-based extrapolations lead to severe under- or overestimations of microplastic concentrations, and an underestimation of polymer diversity

KuramBio II
DFG Deutsche Forschungsgemeinschaft German Research Foundation
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