POLYCYCLIC AROMATIC HYDROCARBONS AND TOTAL HYDROCARBONS IN MARINE SEDIMENTS FROM ISFJORDEN, SVALBARD

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1 Introduction

Svalbard is a high-Arctic island group located about 1000 km north of the mainland of Norway. Despite its remote location and Arctic climate, there are and have been several human settlements on the island. Today there are two relatively large and one smaller active settlement based around mining activities on the island; Longyearbyen, Barentsburg and Svea. Two other settlements based on mining activities have been abandoned; Pyramiden (abandoned in 1998) and Colesbukta (abandoned in 1962).

It is a well known fact that Arctic areas, such as Svalbard, are recipients of contaminants transported through air and ocean currents from industrialised areas further south[1,2]. The fjord areas outside the settlements on Svalbard therefore receive contaminants both from long-range transport and from local sources. Potential local sources include mining operations, traffic (cars, snow scooters, ships), sewage and waste dumps. From previous studies it is known that the marine areas outside the settlements have higher concentrations of THC and PAH than sediments from open sea areas around Svalbard[3, 4, 5].

The main objective of the present study was to monitor levels of selected organochlorines in four coastal areas in the Isfjorden-complex potentially affected by activity related to the settlements Longyearbyen (Adventfjorden), Barentsburg (Grønfjorden) and Pyramiden (Billefjorden). In addition, one area that has been abandoned for more than 40 years, Colesbukta, was also included in the study.

2 Materials and methods

Field work: The sampling was carried out from *MS Nordsyssel* from 29. September – 1. October 2005. Eight sediment samples were collected from each area (Figure 1) with a 0.1 m^2 Van Veen grab. The surface sediment (0 – 1 cm) was transferred to burned glass-jars and frozen on board to -20 °C.

***Analyses*:** Eight samples from each of the three fjords Adventfjorden, Grønfjorden and Billefjorden were included in the analytical programme, whereas only three samples from Colesbukta were analysed.

***TOC and grain size*:** Total organic carbon (TOC) was determined using a Leco IR 212 carbon analyser. Grain size (<> 63 µm) was determined by wet sieving.

THC and PAH: The sediment samples were saponificated with methanol and potassium hydroxide and then the hydrocarbons was extracted from the sediment by using pentane. Thereafter the extract was concentrated and cleaned on a silica column. The relevant hydrocarbons was then separated and quantified. The THCs and PAHs was quantified by using gas chromatography. A GC/FID detector and an external standard was used for the PAHs while an internal standard and CC/FID detector was used for the THCs.

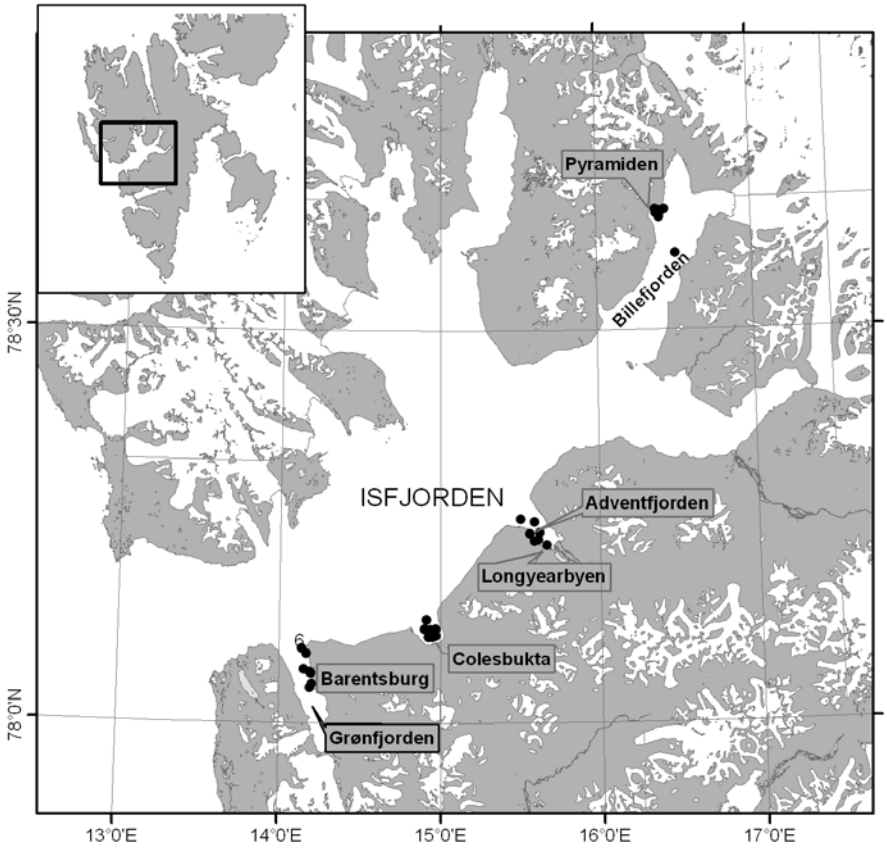

Figure 1. Map of Isfjorden, Svalbard, showing sampling stations as black points. The sampling was carried out in September 2005.

3 Results and discussion

Sediment characteristics: On most stations the sediment was relatively fine grained (> 70 % < 63 µm) (Table 1). High concentrations of organic carbon (up to 275 mg/g) were measured on several stations in Grønfjorden (Table 1). The reason for this is probably discharges of sewage into the fjord, as well as dumping of excrements from domestic animals. Also in Adventfjorden TOC-levels were higher that the assumed background level for Svalbard fjords[4]. Also in Adventfjorden sewage from the settlement is discharged directly into the fjord. Low levels of organic carbon were measured in sediment collected outside the abandoned settlements in Billefjorden (Pyramiden) and Colesbukta.

THC and PAH: There were considerable differences in levels of THC and PAH between the different sites. The highest concentrations of THC were measured in sediments from Adventjorden followed by Grønfjorden. The highest THC concentration (159 mg/kg) was registered a Station 15 just south of Adventpynten. The lowest concentrations were measured in Billefjorden. Generally, the levels of THC and PAH included in the present study were higher than concentrations measured in open sea areas around Svalbard[5].

In all the samples the amount of the NPDs is 5 to 10 times higher than the PAHs. This indicates that the sources for the PAHs probably are less related to combustion. Further with such a high NPD versus PAH ratio a reasonable explanation would be to connect the results to oil related sources. However previous analysis of PAHs in coal from Svalbard proves that component composition of coal is very similar to the component composition in the sediment samples. This indicates that coal is the most important source for the PAHs found in the sediments.

The mining activity represents a local source for the PAHs. Handling and storage of coal will lead to distribution of particles to the environment by air and runoff. The differences in levels between the different sites are related to this mining activity but also to human activity. Sediments Adventfjorden and Grønfjorden clearly have the highest concentrations of THC and these fjords also have the two largest settlements, Longyearbyen and Barentsburg, both with mining activities. Further natural erosion from rock ground containing coal will also contribute to erased levels of PAHs in sediments close to Svalbard.

Due to runoff from glaciers the sedimentation rate is high in the investigated fjords[4]. A combination of high sedimentation rates and elevated levels of persistent organic compounds indicates that the fjord areas outside the main settlements on Svalbard are still receiving significant amounts of contaminants from local, as well as remote sources.

Table 1. Concentrations of THC and PAH (μg/kg dw) in sediment from Isfjorden, Svalbard, September 2005.

Station	Area	Settlement	Grain size % < 63 μm	TOC (%)	THC (mg/kg dw)	Sum 16 EPA-PAH (μg/kg dw)	Sum NPD (μg/kg dw)
LYB 1	Adventfjorden	Longyearbyen	35.97	0.89	77,6	2 488	16 834
LYB 2	Adventfjorden	Longyearbyen	94.28	2.07	101,0	3 362	18 749
LYB 3	Adventfjorden	Longyearbyen	97.20	3.44	77,1	2 982	17 502
LYB 4	Adventfjorden	Longyearbyen	85.05	2.14	65,8	2 109	11 626
14	Adventfjorden	Longyearbyen	98.75	2.27	109,0	4 120	23 276
15	Adventfjorden	Longyearbyen	96.62	2.07	159,0	6 595	35 590
16	Adventfjorden	Longyearbyen	92.77	1.71	90,3	3 537	18 957
BB 1	Grønfjorden	Barentsburg	86.29	4.06	79,9	2 705	17 761
BB 2	Grønfjorden	Barentsburg	28.24	16.50	120,0	5 009	35 048
BB 3	Grønfjorden	Barentsburg	42.17	1.42	71,3	1 994	11 695
5	Grønfjorden	Barentsburg	77.21	1.90	68,7	1 715	10 651
6	Grønfjorden	Barentsburg	74.74	1.49	57,0	1 837	32 471
7	Grønfjorden	Barentsburg	27.09	27.50	75,5	4 497	14 538
8	Grønfjorden	Barentsburg	93.94	1.86	75,3	2 402	3 100
PYR 1	Billefjorden	Pyramiden	98.95	0.65	19,1	941	3 102
PYR 2	Billefjorden	Pyramiden	97.33	0.64	20,9	925	2 872
PYR 3	Billefjorden	Pyramiden	94.36	0.76	14,6	875	2 849
PYR 4	Billefjorden	Pyramiden	94.74	0.90	16,0	895	3 029
4	Billefjorden	Pyramiden	94.78	0.70	31,4	658	3 029
10	Billefjorden	Pyramiden	96.87	0.78	25,4	955	3 068
11	Billefjorden	Pyramiden	95.32	1.26	18,7	847	2 515
CB 1	Colesbukta	Colesbukta	98.96	1.37	51,6	1 702	11 006
CB 3	Colesbukta	Colesbukta	96.98	1.35	48,8	1 845	12 263
CB 5	Colesbukta	Colesbukta	86.46	1.34	51,9	1 582	9 007

* Sum of CB 28, 52, 99, 101, 105, 118, 138, 180, 183, 187 and 194

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