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EVALUATION OF ORGANIC CONTAMINATION IN SEDIMENTS FROM POTTER COVE, KING GEORGE ISLAND, ANTARCTICA, USING MOLECULAR MARKERS

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Abstract: *Potter Cove (62°14'S, 58°39'W) is a small fjord on the southwest coast of King George Island, South Shetland Islands, and where the Argentine Carlini station is located. In order to evaluate a possible input of oil and/or sewage, related to anthropogenic activities, 12 sediment samples were collected to analyze different organic markers: aliphatic and aromatic hydrocarbons, and fecal sterols. The concentrations of aliphatic and polycyclic aromatic hydrocarbons were lower in comparison to marine sediments contaminated by oil hydrocarbons, indicating natural sources and little contribution from petrogenic and combustion sources of these compounds. The concentrations of sewage molecular markers were lower than levels found in contaminated areas and other Antarctic places. Despite the detection of organic compounds related to human activities, these results showed that the Potter Cove region may be considered less impacted by oil hydrocarbons and sewage input.*

Keywords: Petroleum Hydrocarbons, Sewage, Carlini Station, Antarctica

Introduction

Since 1950, research stations have been installed in Antarctica in order to study this unique ecosystem. Human occupation has been responsible for several environmental changes, due to the direct oil input, the combustion of fossil fuels and the sewage discharge in the marine environment (Tin *et al.*, 2008). In order to avoid irreversible damage, monitoring studies have been done around scientific stations.

The use of molecular markers is important to study the origin and composition of sedimentary organic matter because it has specific sources (natural or anthropogenic), chemical stability and resistance to degradation (Colombo *et al.*, 1989). The aliphatic hydrocarbons (AHs) and polycyclic aromatic hydrocarbons (PAHs) can be used to indicate the presence of oil residues (AHs) and to distinguish between pyrogenic or petrogenic sources (PAHs) (Bicego *et al.*, 2009). Sewage input can be evaluated by fecal

sterols that can be found in mammals feces (coprostanol) and is formed mainly during wastewater treatment and sewage sludge digestion (epicoprostanol) (Mudge & Lintern, 1999).

The aim of this study was to evaluate the status of oil and sewage contamination on surficial sediments of Potter Cove, using molecular organic markers as indicators of environment conditions.

Material and Methods

Study Area

Potter Cove is a fjord-like inlet located in the Maxwell Bay, King George Island, (62°14'S; 58°40'W) (Figure 1). The Argentine research station, built in 1952, is located in the Potter Peninsula, south of Potter Cove (Curtosi *et al.*, 2007). This station had a sewage system to treat the raw

effluent before disposal, but due to technical problems its operation was interrupted in 2009.

Sampling and Analytical Procedure

Sediments were collected in the austral summer of 2010-2011 with a Van-Veen sampler (250 cm²). Twelve samples were collected in Potter Cove, according to an increased distance gradient from the sewage outfall (Figure 1).

The laboratory procedure was based on methods described in detail by UNEP (1992) with modifications. Around 15g of sediments from each site were Soxhlet extracted. The extract was reduced by rotoevaporation and submitted to a clean-up procedure by chromatographic column, using alumina and silica. The molecular markers were eluted in three fractions (F1 – AHs; F2 – PAHs; F3 – fecal sterols). Fractions 1 and 2 were concentrated to 1 mL in *n*-hexane. Fraction 3 was evaporated to dryness, derivatized and diluted to 1 mL in *n*-hexane. The organic

compounds were determined by gas chromatography with flame ionization detector (GC-FID: AHs and sterols) and with a mass spectrometer (GC/MS: PAHs).

Results

Concentrations of the organic compounds in the Potter Cove sediments are shown in Table 1.

Discussion

The concentrations of AHs and PAHs were lower than levels established as indicative of hydrocarbons contamination in marine sediments (Volkman *et al.*, 1992; Notar *et al.*, 2001). Despite the low levels, the majority of sediments analysed presented PAHs from petrogenic source, due to the predominance of 2-3 rings and alkylated PAHs, which could be related to ships and boats. Sample #8 presented UCM and 4-6 rings PAHs, indicating the

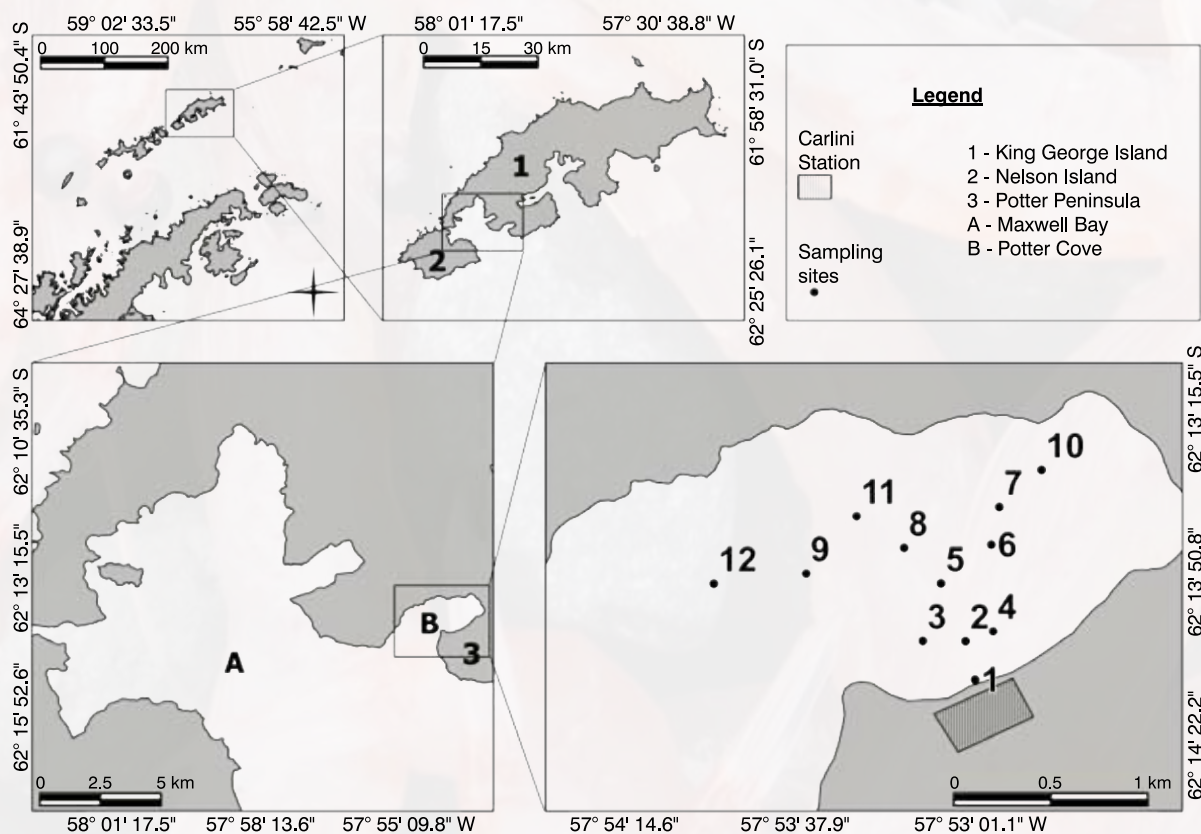


Figure 1. Sampling points at Potter Cove, King George Island, Antarctica.

presence of pyrogenic sources and degraded oil residuals. Coprostanol concentrations were below $0.5 \mu\text{g}\cdot\text{g}^{-1}$, value indicated by González-Oreja & Saiz-Salinas (1998) as indicative for sewage contamination.

A comparison of molecular markers concentrations in superficial sediments of Potter Cove and Admiralty Bay (Bicego *et al.*, 2009; Curtosi *et al.*, 2009; Martins *et al.*, 2012)

is presented in Figure 2. The values obtained in Potter Cove are lower than those found in Admiralty Bay, probably due the small size of Carlini station and, consequently, less human activities, and the local hydrodynamic, which favors the dispersion of the organic compounds. The anthropogenic input in Potter Cove was related to shipping traffic and the fossil fuels / biomass combustion (Curtosi *et al.*, 2007).

Table 1. Concentration of AHs ($\mu\text{g}\cdot\text{g}^{-1}$), PAHs of ($\text{ng}\cdot\text{g}^{-1}$), and fecal sterols ($\mu\text{g}\cdot\text{g}^{-1}$), and related parameters, in sediments collected at Potter Cove. UCM: Unresolved Complex Mixture; nd: not detected.

Parameters/ Sites	1	2	3	4	5	6	7	8	9	10	11	12
Total AHs	1.39	1.10	1.15	1.52	1.71	1.37	1.69	3.23	1.18	1.10	1.20	1.43
n-alkanes	0.13	0.06	0.03	0.10	0.18	0.09	0.07	0.41	0.06	0.07	0.09	0.06
UCM	nd	nd	nd	nd	nd	nd	nd	2.17	nd	nd	nd	nd
Total PAHs	13.1	12.1	14.4	14.2	210.0	13.2	12.6	59.0	18.6	16.9	14.4	14.3
alkyl-PAHs	6.65	5.35	6.29	5.62	135.2	6.30	6.17	12.2	9.31	7.31	5.64	7.94
(2-3)/ (4-6)	14.0	18.4	23.5	5.14	3.06	18.4	13.6	0.49	10.6	20.1	6.11	21.3
coprostanol	0.04	0.06	0.04	0.03	0.06	0.03	0.03	0.07	0.08	0.04	0.04	0.02
epicoprostanol.	0.02	0.03	0.02	0.01	0.02	0.02	0.02	0.02	0.03	0.04	0.02	0.01

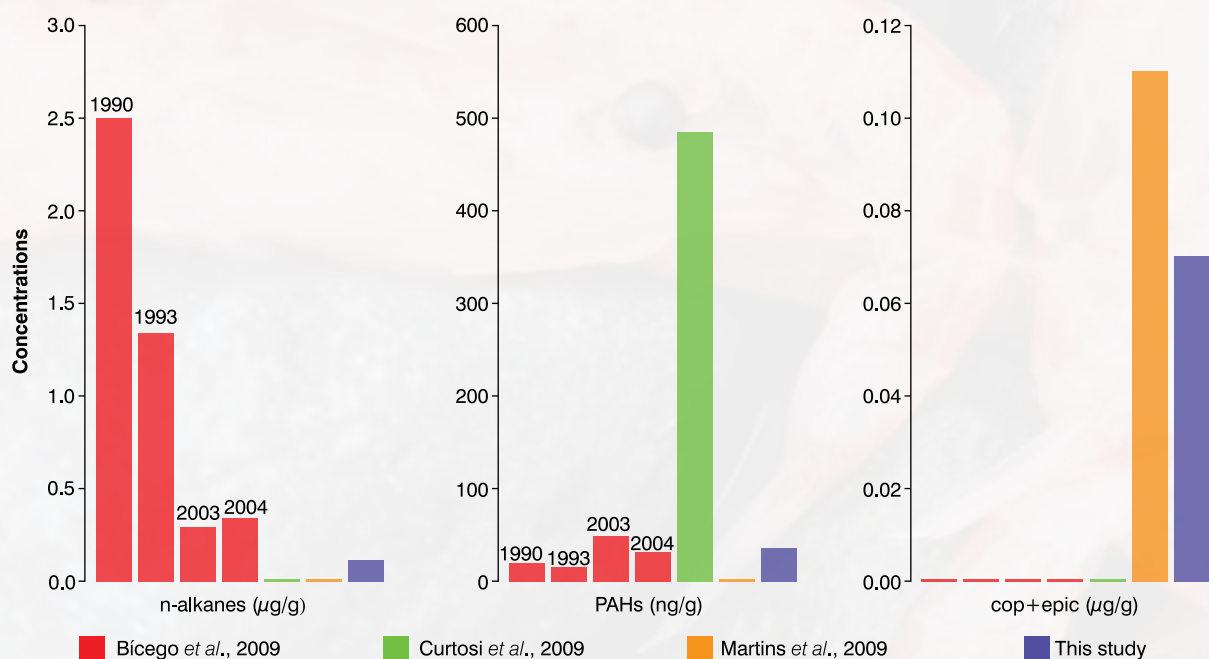


Figure 2. Comparison between the molecular markers (mean concentrations) in Potter Cove and Admiralty Bay.

Conclusion

The concentrations of the petroleum hydrocarbons did not indicate contamination, and were basically originated from natural sources and/or the shipping traffic in Potter Cove. The values of the fecal sterols also were low. Comparing to concentrations found in the vicinity of Ferraz Station, Potter Cove seems to be a more pristine environment than Admiralty Bay. Despite low concentrations of sewage organic markers and oil related hydrocarbons, monitoring programs and the reactivation of sewage treatment are required to determine continuing trends and prevent the increase of anthropogenic impacts.

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