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Examination of Fresh Water Chemistry in Maritime Antarctica during Austral Summer 2017

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Abstract. Due to the fact that Antarctica is one of the least polluted places on Earth, it is a perfect place to observe the spread of global pollution. Therefore, research conducted on this continent is important due to the possibility of investigating the type of pollution and their way of transport. This work considers presence of organic contaminants in Maritime Antarctica in unexplored until now, Lions Rump headland. Qualitative and quantitative analysis of samples were carried out in order to determine the content of analytes such as polycyclic aromatic hydrocarbons (PAHs). Among all determined PAHs in water samples the highest concentrations was observed for naphthalene and anthracene, which is the result of their higher volatility in comparison to the High Molecular Weight PAHs. The presence of PAHs in the water environment may constitute potential negative effect on Antarctic ecosystem and it should be investigated in detail. Moreover, possibility of undertaking various actions reducing contaminants emission are also very important. We hope that improved fossil fuel economy, and not only on the local scale, would help reduce PAH levels in Maritime Antarctica.

INTRODUCTION

Nowadays, it is difficult to indicate a place free of anthropological impact. Depending on the location, the human impact on the environment is more or less intense. Nevertheless, there are still places on Earth with negligible anthropological activity. One of them is Antarctica. This area has not been subjected to significant anthropogenic changes due to the extreme climatic conditions occurring in this area. Such place as Antarctica is an extraordinary source of information about the processes taking place in the environment. However, it should be remembered that it is not possible that those areas would be deprived of anthropological impact due to the occurrence of global anthropression.

Currently, there are many articles about the anthropogenic pollution found in the Antarctica region. The first research and, consequently, articles about pollutants founded in this part of the world come from the second half of the twentieth century. Researches payed attention on abiotic elements such water, snow and air or contaminations found in biotic elements. Researches include both in-organic and organic contaminations. For example, since the 1960s, researches on the presence of pollutants from the group of persistent organic pollutants (POPs) has been undertaken. The presence of pollution in a place like Antarctica is associated with various processes. Thus, for example

semi-volatile and volatile compounds may reach Antarctica together with air masses moving in this direction. This kind of air mass transport is called long-range atmospheric transport (LRAT). However, more attention has been paid to determine of local impact on Antarctic environment associated with the occurrence of many research stations. Due to increasing factors affecting the pollution level, monitoring of different types of pollution has become an important aspect of researches in this region. Special attention in terms of monitoring of the environment merits specially protected areas. There are 72 of Antarctic Specially Protected Areas in Antarctica. These areas have been selected and covered by a special protection for various reasons. Some of them have a rich flora or fauna and they are a valuable place for scientists, others are important for historical or aesthetic reasons. In this study water samples from two protected areas were tested. Both areas ASPA 128 and ASPA 151 are protected for many reasons, but the most important is the presence of many species of birds and penguins in these region.

In this work presence of polycyclic aromatic hydrocarbons (PAHs) found in water samples collected on King George Island, the largest island in the South Shetland, is discussed. These samples of surface water were taken on Lion Rumps headland. Furthermore, this type of study has never been conducted in ASPA No. 151 and its surroundings, hence our findings will have great value for this local Antarctic environment.

SAMPLING

Sampling campaign have been performed during the austral summer 2016/2017. The water samples were collected manually into plastic containers of 1L volume. After collection, all samples were transported to the H. Arctowski Antarctic Station Laboratory and stored frozen at -20°C , and then transported under unchanged temperature conditions to Poland. The specific regions of sampling are shown in Fig.1

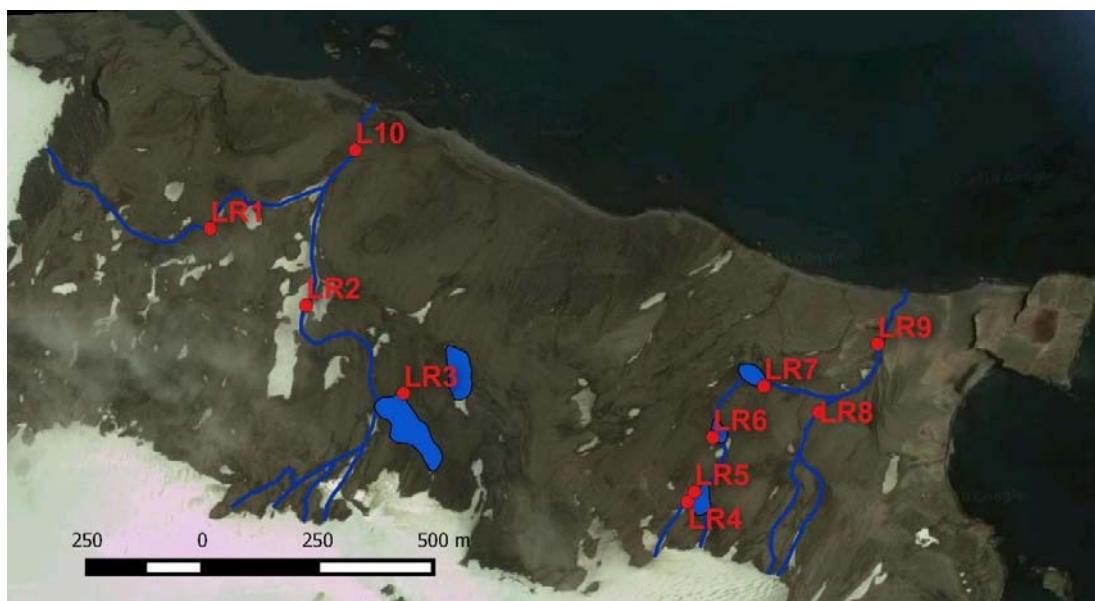


FIGURE 1. Location of sampling points on Lion Rumps headland.

Polycyclic aromatic hydrocarbons (PAHs, ngL^{-1}) were identified and quantified with the use of gas chromatography coupled with single quadrupole mass spectrometer (GC-MS) – Agilent 7890A system (Agilent Technologies, USA). The determination of selected PAHs was performed based on the internal standard calibration method. Before extraction surrogate standards has been added.

RESULTS AND DISCUSSION

Despite its pristine environment, scientific, logistic and touristic activities in the South Shetland Island Archipelago have introduced anthropogenic compounds. Those activities are related to oil storage, fuel combustion, and human waste production. The use of fuel is the main source introducing hydrocarbons into the environment. The principal

Antarctic sources of PAHs are the direct input of fossil fuels and inputs associated with incomplete combustion. Arctic Grade Diesel Fuel is the principle source of energy in Antarctic operations and it consists mainly of semi-volatile aromatic hydrocarbons, including naphthalene and various other non-substituted PAHs containing two or three aromatic rings. However, Arctic Diesel Fuel also has a higher level of complex compounds featuring four or more rings.

The samples were analyzed against the presence of the following compounds, which belong to the PAHs: naphthalene, acenaphthylene, 2-bromonaphthalene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benz[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[a]pyrene, indeno[1,2,3-cd]pyrene, dibenz[a,h]anthracene and benzo[ghi]perylene. The highest concentration was detected in the sample specified by the LR1 and the sample specified by LR4 number. In the first case, a concentration of 18.2 ng/L of anthracene was detected and in sample fourth the same concentration of naphthalene was detected. Whereas, the largest amount of different compounds was detected in the sample described as LR4. Seven of total eight founded compounds are detected in this sample. It is worth to mention, that these above-mentioned samples were collected in the upper part of the watercourse. The most polluted place is the upper part of the watercourse (Fig. 2). As it can be noticed from this figure, the estuaries of the watercourse is also the place where most of the compounds have been detected. On the other hand, lakes and waterfall are the places where the smallest amount of compounds were detected. However, the naphthalene concentration in both lakes and waterfall is similar to concentration of this compound detected in upper part of watercourse and its estuaries.

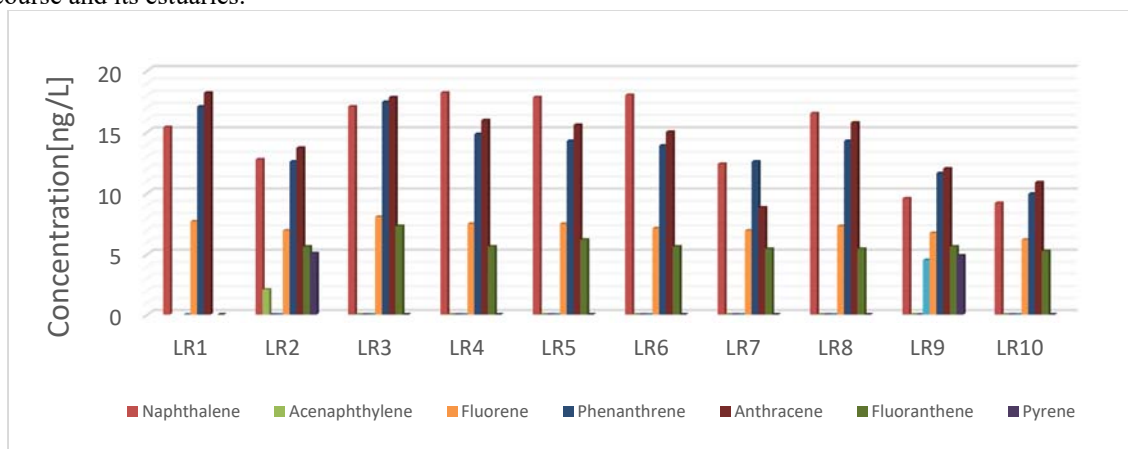


FIGURE 2. Concentration of the individual PAH in the samples taken on Lions Rumps region.

CONCLUSIONS

Antarctica, despite the fact that it is deprived of permanent residents and its localization, which is far away from developed countries, is affected by anthropogenic pollution. Scientists identify pollution across continent that affects biotic elements as well as abiotic elements of Antarctica. Due to the presence of numerous types of pollution in Antarctica, it is necessary to monitor the environment. The issue of monitoring pollution in the Antarctica should be conducted in detail, especially in terms of examination external locations of pollution sources, because they may affect not only Antarctica, but the whole world. Among all determined PAHs in water samples the highest concentrations was observed for naphthalene and anthracene, which is the result of their high volatility. Naphthalene is the most volatile compound of all PAHs, which means that these compounds are relatively easily transported by air (LRAT). It is also worth to noticed that the compounds listed above belong to products of petroleum origin. Thus, their presence may be related to the local activity of a people (the use of fuels on the King George Island). The degradation of compounds from the group of PAH is very difficult due to the low temperature conditions prevailing there. Summer thaws cause release of petroleum products to fresh and marine water. Such products are very dangerous for living organisms that need water to live. Due to the low diversity of flora and fauna in the Antarctica area, PAHs may accumulate in the organisms of such as penguins, fish or fowl. Therefore, their presence may negatively influence indigenous species.

ACKNOWLEDGMENTS

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