Atlantic Ocean study reveals reduction in leaded petrol emissions

29 September 2016

Scientists have detected significant amounts of naturally sourced lead in the North Atlantic Ocean for the first time in 40 years, suggesting a decline in lead produced by human activities, particularly leaded petrol emissions.

For much of the last century, the amount of lead from human activity in the oceans was so high that it was difficult to detect any lead from natural sources.

The study found that lead in Atlantic Ocean surface waters now consists of up to 30-50% naturally sourced lead. This suggests that the global drive to phase out leaded petrol emissions has reduced, in certain areas of the ocean, the levels of lead produced by human activity.

Dr Luke Bridgestock, who carried out the study while completing his PhD at Imperial College London, said, 'The proportion of lead from human activities and naturally occurring sources in the surface of our oceans reflects the extent of environmental lead pollution. That is why [this] find is encouraging. It demonstrates how effective policies to phase out leaded petrol have been.'

The research, published this week in Nature Communications (http://www.nature.com/articles/ncomms12921), was led by a team of scientists at Imperial College and collaborators including the Natural History Museum. The team studied the chemistry of water and air samples collected from the tropical North Atlantic Ocean during research cruises in 2010 and 2011.

A delicate balance

Lead is a natural and harmless component of ocean waters. The main natural source of lead in Atlantic Ocean surface waters is the North African dust plume, which carries mineral dust whipped up from dry areas in North Africa.
During the last century, the widespread use of leaded petrol in cars and other engines released significant volumes of lead into the atmosphere. That lead made its way to the oceans and overwhelmed lead from natural sources.

'This is the first time since similar studies began in the late 1970s that natural lead in the ocean has been at an observable level,' said researcher Dr Tina Vann de Flierdt of Imperial College London. 'However, this finding is confined to this particular region of the North Atlantic, and pollutant lead from industrial processes is still dominant in this ocean and elsewhere.'

While none of this lead is present at levels that pose a health risk to humans or marine life, the changing proportions of natural and unnatural lead in the oceans is a valuable indicator of pollution levels in the atmosphere.

Dr Stanislav Strekopytov, analytical chemist at the Museum says, '[The study] adds to our knowledge of the biogeochemical cycle of lead - one of the important anthropogenic contaminants. It also gives us a real-life example of how quickly chemical elements are exchanged in the marine environment.'

Misleading results
The team focused on the tropical North Atlantic, a specific area of the ocean that receives particularly high levels of natural lead. This means the results represent an optimistic view of natural lead levels worldwide.

'The big catch… is that lead pollution from other sources is still high, overall remaining dominant over naturally occurring lead in the oceans,' said Dr Bridgestock.

In fact, lead pollution in the Indian Ocean has increased in recent years, due to the industrialisation of nearby countries. Since the 1970s, countries have introduced a number of policies aimed at phasing out leaded petrol use, in an effort to reduce lead pollution. Until now, scientific expeditions have been unable to detect any naturally occurring lead because large amounts of lead from human activity caused a masking effect.

'I think one of the most important outcomes of this paper is that it highlights a success of environmental policy,' says Dr Strekopytov. 'It is nice to see that at least some anthropogenic contamination in the ocean is reversible within a reasonable timescale.'

Identifying the source

To separate the relative proportions of lead from natural and artificial sources in their water samples, the team looked at isotopes - different forms of lead with slightly different atomic properties.

The GEOTRACES team collected surface seawater samples across the Atlantic Ocean. In each sample, they determined the relative quantities of naturally sourced lead as well as lead produced by human activity © Dr Angela Milne ([https://www.plymouth.ac.uk/staff/angela-milne](https://www.plymouth.ac.uk/staff/angela-milne)), Plymouth University.

The relative quantities of lead isotopes in a given sample depend on where the isotopes came from. Some originate from radioactive elements like uranium and thorium, which are present in different proportions in different geological settings. The team used this principle to identify the distinct isotopic signature of both naturally sourced lead and lead produced by human activity.

During the research cruises the team also collected samples of aerosols - fine solid or liquid particles suspended in the air above the ocean.

Museum scientists Dr Strekopytov and Dr Emma Humphreys-Williams used the Museum’s sensitive analytical equipment to measure the concentration of lead in these aerosol samples, as well as aluminium, an indicator of naturally sourced lead.

Future of the oceans

The study is part of the GEOTRACES project, an ongoing international effort to understand the cycling of trace metals - such as lead - in the world’s oceans. The team’s next task is to learn more about ocean circulation patterns, by tracking individual parcels of polluted water as they travel into the deep ocean.
Scientists at the Museum’s Imaging and Analysis Centre are currently working with Imperial College and other institutions to understand the various sources of trace metals in the atmosphere.

Meet Dr Strekopytov and other Museum researchers at Science Uncovered (http://www.nhm.ac.uk/visit/exhibitions/science-uncovered-2016.html), our free annual festival of science on Friday 30 September 2016.

- By Kate Hazlehurst

Related information

- Read the paper on the Nature Communications website (http://www.nature.com/articles/ncomms12921)
- Learn more about the Museum's Imaging and Analysis Centre (http://www.nhm.ac.uk/our-science/departments-and-staff/core-research-labs/imaging-and-analysis-centre.html)

Discover more