



Singapore-MIT Alliance for Research and Technology

News Release

Immediate release

First high-fidelity coral-based lead (Pb) study in Singapore and Indian Ocean

- *SMART unveils history of heavy metal lead (Pb) level and its sources in Singapore and Indian Ocean over the past decades*
- *Indian Ocean lead history is consistent with leaded gasoline consumption in the region*
- *Lead in the Straits of Singapore has been decreasing in recent years likely due to the recent phasing out of leaded gasoline in the Southeast Asia region, but sources of lead in Singapore waters perplex scientists*

1. Singapore, 1 Jul 2014 – Scientists at the Singapore-MIT Alliance for Research and Technology (SMART)[新加坡-麻省理工学院科研中心] have reconstructed the history of heavy metal lead (Pb) level and sources in Singapore waters and the Indian Ocean. While lead concentrations decreased in the North Atlantic Ocean by almost 10-fold after 1970s with the regional phasing out of leaded gasoline consumption, the opposite has occurred in the surface of Indian Ocean. They have found that lead concentrations in the Indian Ocean and the Straits of Singapore rose from the mid-1970s until early 2000s. This lead concentration has declined since, but the current concentrations are now three times higher than that in the North Atlantic and North Pacific Oceans.
2. These findings are a result of the measurement of heavy metals such as lead (an indicator of industrial activities in the oceans) in the corals, which were drilled from the Chagos Archipelago, west Sumatra and Singapore's Jong Island.
3. Monitoring lead in our marine environments remains an analytically challenging task, and that high-fidelity data is produced from a few inter-calibrated labs such as the one led by Prof Edward Boyle at the Massachusetts Institute of Technology (MIT). Prof Boyle, SMART Principal Investigator, together with Dr Jong-Mi Lee (MIT Postdoctoral Researcher), Dr Intan Suci Nurhati (SMART Senior Postdoctoral Associate) and collaborators from Germany, Indonesia and Singapore's Nanyang Technological University contributed to this study.
4. Prof Boyle, who is also the professor of ocean geochemistry in MIT Department of Earth, Atmospheric and Planetary Sciences, explained: "Central and East Asian, as well as African countries lagged North America and Europe both in industrialization and in phasing out leaded gasoline. As a result, the Indian Ocean has had less time than the Atlantic and Pacific to dissipate lead pollution."
5. In analysing their samples, the researchers were also puzzled by an odd measurement: In samples taken off the coast of Singapore (Jong Island), they found the imprint of lead that they did not expect to find in this region of the world. While most countries around the Indian Ocean used leaded gasoline produced in Europe and the Middle East, the lead found near Singapore matches the kind once used in North American gasoline. Prof Boyle said: "It's almost as if Singapore had gone off and imported a whole lot of lead from the United States. It doesn't make any sense why they would do that, because there are more local sources that presumably would be cheaper, more economical."

6. Dr Nurhati added: “We try to make sense of this mystery by regularly monitoring lead in seawater and aerosol. Lead in the air seems to be consistent with what we expect to find in the region, but our seawater sampling data lends support to the unexpected lead value that we see in coral. In this recently published paper, we conclude that leaded gasoline may not be the primary driver of lead deposited in Singapore waters; there are other sources to consider such as coal as well as complex sources and processes in the Straits of Singapore. Ultimately, we hope this data would help Singapore and stakeholders in our region in monitoring heavy metal pollution level and sources in our nearby oceans with respect to existing environmental regulations.”

7. The research team began collecting coral and water samples in Singapore in 2010, as well as gathering corals from the Indian Ocean through their collaborators. Upon bringing the coral samples back to the lab, the researchers analysed the corals for trace amounts of lead as well as lead isotopes which is a tool to pinpoint the source of lead. This is because lead ores from different mining sites have different lead isotope signatures. Akin to trees, corals form annual layers that lock in information on lead in seawater during the formation of the layers – and this process goes on throughout the lifetime of the corals which could live for decades. By ascertaining how much lead and what signature of lead isotope was deposited in a given annual layer, the researchers were able to reconstruct a history of lead level and sources in Singapore and the Indian Ocean over the past 60 years, which is the time when there was no monitoring data. They found that lead levels began to increase in the mid-1970s, peaking in 2002 and 2003 before declining — a timeline consistent with the region’s pattern of industrialization and leaded gasoline use.

8. This research - [‘Coral-based history of lead and lead isotopes of the surface Indian Ocean since the mid-20th century’](#) - is published in the July 2014 issue of Earth and Planetary Science Letters volume 398, page 37. It is funded by the Singapore National Research Foundation (NRF), Prime Minister’s Office, Singapore under its Campus for Research Excellence And Technological Enterprise ([CREATE](#)) programme.

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About SMART

The [SMART](#) Centre is a major research enterprise established by the Massachusetts Institute of Technology (MIT) in partnership with the National Research Foundation of Singapore (NRF) since 2007. It is the first entity in the Campus for Research Excellence and Technological Enterprise (CREATE) developed by NRF.

The SMART Centre serves as an intellectual hub for research interactions between MIT and Singapore. Cutting-edge research projects in areas of interest to both Singapore and MIT are undertaken at the SMART Centre. SMART comprises an Innovation Centre and five Interdisciplinary Research Groups (IRGs): BioSystems and Micromechanics (BioSyM), Center for Environmental Sensing and Modeling (CENSAM), Infectious Diseases (ID), Future Urban Mobility (FM) and Low Energy Electronic Systems (LEES).

About SMART CENSAM IRG

Using measurements from a variety of sensors and sensor networks, the [Center for Environmental Sensing and Modeling \(CENSAM\)](#) IRG aims to develop an accurate and predictive model of the natural and built environment of Singapore that seamlessly transitions between different scales, from the level of a single building or facility to the level of the state, including the surrounding seas.

About CREATE

CREATE is an international collaboratory housing research centres set up by top universities. At CREATE, researchers from diverse disciplines and backgrounds work closely together to perform cutting-edge research in strategic areas of interest, for translation into practical applications leading to positive economic and societal outcomes for Singapore. The interdisciplinary research centres at CREATE focus on four areas of interdisciplinary thematic areas of research, namely human systems, energy systems, environmental systems and urban systems. More information on the [CREATE programme](#) and the [CREATE factsheet](#) can be obtained from www.research.gov.sg.

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FACTSHEET

About lead (Pb)

Since the 1970s, leaded gasoline has been slowly phased out worldwide, as studies have shown that lead can cause neurological and cardiovascular damage and degrade vehicles' catalytic converters. While leaded gasoline usage has decreased drastically in the last few decades, lead is still pervasive in the environment.

Map of where corals were collected

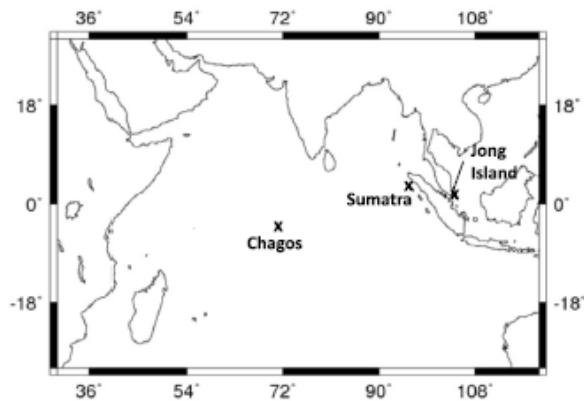


Fig.1 - Corals were sampled from Chagos, west Sumatra and Jong Island in Singapore

Detailed graphical depiction of lead levels at Singapore's Jong Island

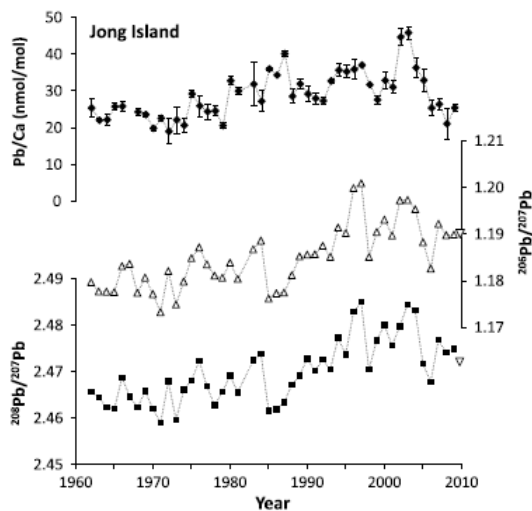


Fig. 2 - Time series of Pb/Ca (\blacklozenge), $^{206}\text{Pb}/^{207}\text{Pb}$ (\triangle), and $^{208}\text{Pb}/^{207}\text{Pb}$ (\blacksquare) ratios in the Jong Island coral. Pb isotope ratios of the seawater (∇) collected at the coral growth site are shown together.