PUBLISHED: 13 FEBRUARY 2017 | VOLUME: 1 | ARTICLE NUMBER: 0075

ECOTOXICOLOGY

Pollutants plumb the depths

An 'underwater elevator' takes research 10,000 m under the sea and reveals a pollution legacy in remote oceanic trenches.

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At more than 6,000 m under the sea, hadal trenches are a remote wilderness, largely unexplored and widely considered safe from human disturbance. Writing in *Nature Ecology & Evolution*, Jamieson *et al.*[1] shine an ecotoxicological spotlight on these deep sea habitats by analysing persistent organic pollutants (POPs) in tiny marine scavengers. They document unexpectedly high levels of industrial chemicals in a habitat formerly considered pristine and highlight the pervasive nature of pollution over space and time.

The deep sea remains one of the world's most inaccessible habitats and we still know more about the surface of the Moon than that of the ocean floor[2]. Until the 1950s, the deepest areas of the ocean explored by humans were <2,000 m deep[1,3]. The relatively recent development of deep sea landers has increased the accessibility of habitats such as the hadal zone, which lies 6,000–10,000 m beneath the ocean surface[4]. Landers provide a platform for sampling equipment and are remotely operated from the surface using free fall to jettison them to the bottom and an acoustic recall at the conclusion of sampling. They have opened up research in the deep sea allowing instrument deployments to measure environmental conditions, capture video of resident marine creatures, and collect specimens for surface examination. Research so far has been illuminating. Despite temperatures that hover around 1 °C and pressures over 1,000 times greater than at the surface, deep sea trenches in the hadal zone support significant endemic biodiversity[3]. However, there is increasing evidence that the unique marine creatures in these trenches are threatened by human-made pollution.

Chemical pollution came under intense scrutiny in the 1960s when Rachel Carson's book *Silent Spring* was published. New awareness of and insight into the environmental impacts of pollution inspired moves towards protection and a ban on indiscriminate use of pesticides in agriculture[5]. Manufactured chemicals such as DDT (dichlorodiphenyltrichloroethane), originally used in pesticides, are part of an extensive group of carbon-based substances now classified as POPs. They also include industrial chemicals such as PCBs (polychlorinated biphenyls) and PBDEs (polybrominated diphenyl ethers) used as flame retardants. The spotlight has hovered over these pollutants due to their capacity to remain viable over long time periods and for long-range transport in material such as soil, water and air. This has increased their pervasiveness in a variety of environments including the Arctic[6] and now the deepest ocean[1]. At the same time they can accumulate at up to 70,000 times background levels in the fatty tissue of living organisms with significant magnification at higher levels in the food chain. These factors, together with their devastating effects on the hormonal, immune and reproductive systems, have been major drivers in their regulation and elimination[7].

Jamieson and colleagues' work explores POP concentrations in two of the deepest hadal trenches; the Mariana Trench in the west Pacific Ocean and the Kermadec Trench near the north-eastern tip of New Zealand (Fig. 1). To sample at depths ranging from ~7,000–10,000 m in each of these trenches, the authors used a deep sea lander and baited traps designed to collect tiny scavengers, amphipod crustaceans. Their results were disturbing. Concentrations of PCBs and PCBEs in these tiny crustaceans were higher than baseline levels and 50 times greater than in crabs from a highly polluted river system in China. This is significant since the hadal trenches are many miles away from any industrial source and suggests that the delivery of these pollutants occurs over long distances despite regulation since the 1970s.

Although the authors were able to quantify concentrations of PCBs and PCBEs in crustacean scavengers from the hadal zone, the source of POPs to these areas and also the mechanisms for delivery remain largely unknown. Furthermore, the toxic

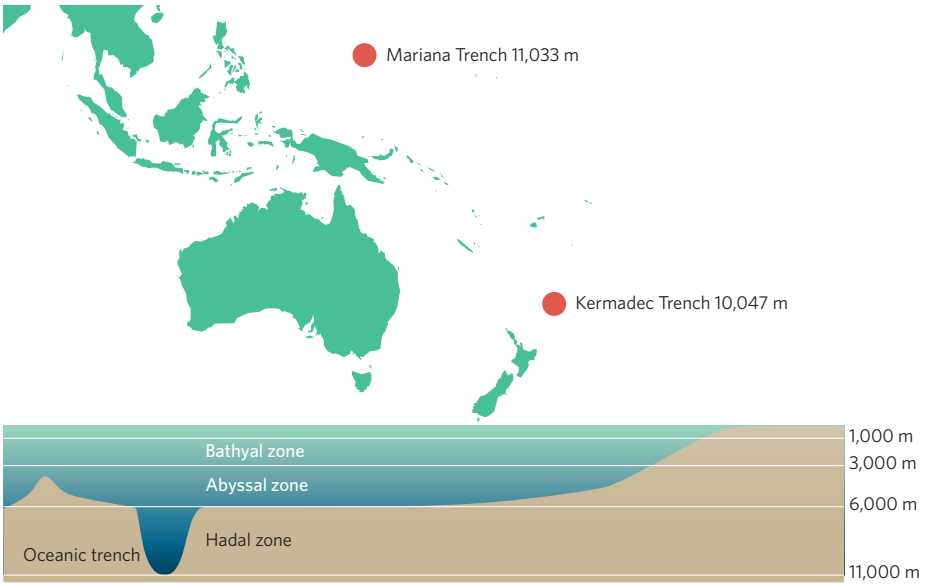

Figure 1 | Deeper and down. Top, locations and depths of the Mariana and Kermadec trenches. Bottom, relative depths of oceanic layers, including the hadal zone (named for Hades, the underworld in Greek mythology).

effects of these pollutants and their potential to biomagnify up the food chain still need to be tested. These knowledge gaps can be addressed through ecotoxicological testing to investigate lethal and sublethal effects, and by assessing the rate of food fall as well as other potential POP sources to the trenches such as microplastics and litter.

Despite these limitations, Jamieson *et al.* have provided clear evidence that the deep ocean, rather than being remote, is highly connected to surface waters and has been exposed to significant concentrations of human-made pollutants. Their findings are crucial for future monitoring and management of these unique environments.❐

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Competing interests

The author declares no competing financial interests.