THE "PLASTICENE" EPOCH?

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This issue of *Elements* explores the fascinating realm of deep-ocean deposits that have the potential to provide society with many of the raw mineral resources required to meet the world's growing needs. While raw materials have always, and always will, play a critical role in meeting these demands, materials made by humans have also become increasingly important, expanding in concert along with the world's population, industry, and resource use. Most notably, plastics, which are synthetic organic polymers derived from fossil hydrocarbons, have become an indispensable part of our material world because of their remarkable number of uses and versatility. Plastic bottles, bags, credit cards, scotch tape, pipes, toys, to name a few, form part of our everyday life. Not surprisingly, the global production of plastic has increased from 2 metric tons (Mt) in 1950 to 380 Mt in 2015 (Geyer et al. 2017). By 2050, Geyer et al. (2017) estimate that roughly 12,000 Mt of plastic waste will be in the natural environment. This is a staggering amount, enough to cover the entire surface of the Earth in a thin layer of plastic! With the growing abundance of plastic, the potential for preservation in the rock record increases. What impact will synthetic materials like plastic have on future deposits in the Earth – will there be a "Plasticene Epoch"?

The fate of plastics over geological timescales is not well known. These organic polymers are relatively inert, insoluble in water, resistant to much biological decay and chemical attack, making their degradation, at least over decades, a slow process. Common forms of plastic, such as polypropylene (bottles) and polyethylene (bags), have densities less than 1 g/cm^3 so they float in water, while other forms, such as nylon (fishing nets) and PVC (pipes), have greater densities so they sink rather than float. Thus, the depositional environment is a critical factor for the preservation and incorporation of plastic in the rock cycle. Zalasiewicz et al. (2015) presented a comprehensive review of the presence of plastic in environments ranging from terrestrial, to lake and rivers, to near- and offshore marine settings. In all environments, they found evidence of macroscopic fragments of plastic (e.g. bottles, bags, etc.) and/or microscopic fragments (e.g. fibers and polyethylene microspheres). Remarkably, plastics are found in deep ocean sediments. The conditions of the deep ocean with colder temperatures and lack of ultraviolet light are especially favorable for their preservation, as are poorly oxygenated environments. In such settings, plastic material might remain preserved in sediments over geological timescales.

FIGURE 1 Plastiglomerate from Kamilo Beach (Hawaii, USA). PHOTO BY PATRICIA CORCORAN, UNIVERSITY OF WESTERN ONTARIO

One of the most fascinating examples of plastic preservation in the rock record was discovered on Kamilo Beach (Hawaii, USA). Corcoran et al. (2013) reported the appearance of a new rock, "plastiglomerate", formed in campfires that melted the plastic that had washed up on the beach. The resulting rock is a mixture of melted plastic, beach sediment, basaltic lava fragments, and organic debris (FIG. 1). The bulk densities of the clastic fragments range from 1.7 to 2.8 g/cm^3, which are much higher than clasts of pure plastic. Thus, plastiglomerate has greater potential to become buried and preserved in the rock record.

In conclusion, there is mounting evidence that plastics are becoming a significant component of the present-day rock cycle, their amount seems certian to grow, making the idea of a "Plasticene Epoch" not so far-fetched. Indeed, plastics are now so ubiquitous in the environment that they can be used as markers of the age and character of the sedimentary deposits that they were buried in. In other words, they are a key geological indicator of the "Plasticene Epoch", more correctly termed the Anthropocene, the epoch in which humans have come to dominate many surface processes (Crutzen and Stoermer 2000).

Over geological time, plastics may be preserved in rocks. Future geologists may identify the remains of plastic bottles as fossils even if the plastic itself has degraded or been replaced by other materials. The hydrocarbons released during diagenesis might contribute to future oil and gas deposits. Ultimately, rocks such as plastiglomerate may be subducted into the Earth forming interesting new metamorphic rocks that have unique compositions, properties and seismic signatures. And as plastic components have become essential components of spacecraft and placed on the surfaces of the Moon and Mars, the impact of plastic stretches far beyond Earth into space!

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