Less mercury?

SIR — Camargo[1] dismisses Nriagu's[2] assertion that mercury emissions from precious-metal refining in the early New World may have an impact on the present-day global mercury cycle. Unfortunately, Camarago's argument is undermined by the use of outdated, poor-quality data collected before people became aware of the need for ultra-clean sample-handling protocols[3-5].

Camarago, for example, cites a 15-year-old EPA report[6], founded on much earlier data, for his assertion that the total natural-source atmospheric Hg emission budget is $25-50 \times 10^9$ g yr^{-1}. But it is now generally accepted that the total gobal atmospheric emission budget is about $6-7.5 \times 10^9$ g/yr^{-1}, with approximately 30–75% of that as natural emissions, and perhaps as much as 20–30% due to fossil fuel combustion[7-11]. Using these values results in more refined estimates of the atmospheric residence time for Hg of 0.5–2 yr (refs. 7, 8, 10).

Camargo also overestimates the potential pool of Hg contained in the oceans by two orders of magnitude, choosing very old and discredited values as representative of the world oceans[12,13]. Using ultra-clean techniques many researchers have now confirmed that ocean water, even near the shore, contains approximately 0.5–1 ng l^{-1} Hg (refs 4, 7, 14), resulting in an estimated 10^{12} g Hg residing there at any one time. From this, we can calculate a mean oceanic residence time for Hg of approximately 350 yr, which is comparable with other particle-reactive metals in the sea[15]. This implies that much of the Hg emitted over the past 500 years still resides in the ocean, where it may be available for methylation, biological uptake, revolatilization, and recycling to the atmosphere[7,16]. Thus, modern and past anthropogenic emissions contribute to an increased global 'background' Hg concentration.

The degree to which the early emissions discussed by Nriagu affect the current budget is difficult to judge because of the incomplete summation of all Hg emissions from that time to the present, and our lack of knowledge as to the degree which Hg stored in deep ocean water is biogeochemically active and available for eventual revolatilization to the atmosphere. For example, it has recently been estimated that 6×10^{10} g Hg entered the environment in the nineteenth century via the recovery of gold and silver during the North American gold rush[17,18]. But without a quantitative estimate for the summation of all releases during this interval it is impossible to compare its impact relative to the earlier and later South American gold rushes.

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Can diamonds be dead bacteria?

SIR — The reports by Lilley *et al.*[1] of isotopically very light carbon in methane from an unsedimented mid-ocean ridge system, and by Schrauder and Navon[2] of the discovery of solid CO_2 in diamond, reinvigorate an interesting question. Although Lilley *et al.* conclude that sediments from turbidites were a more likely source of methane and ammonia, their report raises the question of the long-term future of organic vent communities on unsedimented ridges, destined for eventual subduction. Are eclogitic diamonds fossils? Are they derived from metamorphosed clumps of carbon that originated as bacteria from ancient mid-ocean ridge hydrothermal systems?

The possible organic origin of some diamonds has been pointed out by Kirkley and Gurney[3]. To date, much of the discussion has centred around the possibility that organic material from sediments may have supplied the carbon. However, Deines *et al.*[4], studying websteritic-type diamonds, discounted an organic-sediment origin for the isotopically light carbon on the grounds that a subduction hypothesis would demand an extreme ophiolite differentiate to explain the iron and chromium contents. Such differentiates are unlikely in association with sediments, but are expected near ridge hydrothermal communities.

The case for an organic origin rests essentially on the isotope composition of the carbon in the diamonds occurring in eclogites, which commonly ranges from $\delta^{13}C$ of 0‰ to as light as -25‰, and in rare examples yet lighter, to -35‰. The main source of carbon as light as this is organic. Bacteria show a wide range of carbon isotope compositions. Isotope fractionation in the Rubisco pathway is about -29‰, which with the chemical fractionation between dissolved CO_2 and carbonate (about 11‰) allows a maximum biological fractionation of about -40‰. Perhaps more relevant to the proposed hydrothermal setting is that archaea (such as methanogens) can range further, to extremely light $\delta^{13}C$. Further, the sulphur isotope ratios of many sulphide inclusions in eclogitic diamonds suggests a biogenic origin[5] and the high manganese content of some diamondiferous eclogites and eclogitic inclusions in diamonds[6] is not inconsistent with a hydrothermal source.

Late Archaean and Proterozoic oceanic crust would have contained a thick mafic upper layer, with vigorous hydrothermal circulation. Abundant vent communities may have existed, becoming incorporated into an altered carbonate-rich lava pile and eventually subducted. It is then logical to ask what happened to the bacterial communities that are widely assumed to have been present on Archaean and Proterozoic mid-ocean ridge hydrothermal systems? A possible answer is that some diamonds derived their carbon from bacterial communities, either directly from reduced organic carbon via graphite, or indirectly via a locally generated gas phase that incorporated both very light organic-derived carbon and also CO_2 from carbonate. The original organic carbon may have been in the range -30 to -50‰. Metamorphism tends to shift organic carbon to heavier isotope ratios. The present isotope content of the diamonds would range from near-organic ratios (-35‰) to more common heavier compositions (0 to -25‰) that reflect varying degrees of metamorphism and exchange with country rock carbon from carbonate. There are probably many origins of the carbon in the various types of diamonds, but it is possible that a few diamonds are indeed our ancestral relics.

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