

Canada's mines pose transboundary risks

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LETTERS

Insufficiently regulated contamination from the Elk Valley mines in British Columbia, Canada, threatens downstream ecosystems in both Canada and the United States.

Edited by Jennifer Sills

Retraction

After the publication of our Report “Current-induced strong diamagnetism in the Mott insulator Ca_3RuO_4 ” (1), new measurements performed in Kyoto by Giordano Mattoni *et al.* (2) revealed a serious technical artifact that affected our published data. Specifically, it became clear that a large part of the reported diamagnetic signal arose from a mechanism that we did not anticipate. This signal is attributable to localized heating of the sample holder, caused by the unavoidable Joule heating in the sample.

The published data in Figs. 1A, 1C, and 2B are affected by this artifact. The theoretical model of Fig. 3 remains valid, as it deals with the generic case in which a Mott gap is suppressed. Because the artifact affects the main experimental data, the authors unanimously agreed to retract the Research Article. For the same reason, another work on $\text{Ca}_3(\text{Ru}_{1-x}\text{Ti}_x)_2\text{O}_7$ by some of the present authors published in *Physical Review Letters* (3) is also being retracted (4).

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Canada’s mines pose transboundary risks

In 2019, Canada approved an extension of the deadline to start one of the world’s largest copper and gold mines in the headwaters of the transboundary Unuk River (1). The plan for the Kerr-Sulphurets-Mitchell (KSM) mine is to dig one of the largest human-made holes on earth, erect one of the highest dams in North America, and operate water treatment for 200 years after the mine closes (2). Mines such as KSM pose long-term risks to downstream water quality, fish, and people (3). Given that mine contamination is not constrained by political boundaries, U.S., Canadian, and Indigenous governments must urgently engage in collaborative evaluation and regulation of mines in internationally shared rivers. Shortfalls in mine assessments and permitting policies should be addressed.

Mine assessments underestimate risk at high environmental cost. Contributing factors include the ecological complexity of rivers, policy shortcomings in weighing environmental risk (4), and profound engineering challenges posed by mountain mining. For example, insufficient evaluation

of soil stability enabled the 2014 catastrophic failure of the Mount Polley tailings dam (5).

Furthermore, the issuance of mine permits relies on the promise of mitigations that lack field validation. Canadian industrial projects typically underdeliver on their mitigations, such as restoring fish habitat (6). Unverified technologies can fail, as evidenced by the 2014 fish kill downstream of Teck Resources’ wastewater treatment plant (7).

Finally, mine assessment and permitting do not require incorporation of transparent, independent, and peer-reviewed science (8). For example, Teck’s Elk Valley permit allows contaminant discharges up to 65 times above scientifically established protective thresholds for fish (9). Political borders do not block the downstream flow of this contaminated water into Montana and Idaho (10).

Stakes are high. Upstream Canadian mines threaten downstream economies, waters, and ways of life, even as the United States is currently weakening its own federal environmental regulations (11). Rather than a race to the bottom, we urge our governments to honor their mutual obligations to protect our shared transboundary waters as codified in the Boundary Waters Treaty of 1909 (12) and immediately collaborate on binational environmental reviews that are founded upon independent, transparent, and peer-reviewed science.

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COMPETING INTERESTS

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Investments' role in ecosystem degradation

In their Review "Pervasive human-driven decline of life on Earth points to the need for transformative change" (13 December 2019, p. eaax3100), Díaz *et al.* discuss the

results of the first integrated global-scale assessment report on biodiversity and ecosystem services. The authors identify extraction of resources to provide food, feed, and industrial feedstocks as the main direct driver of the observed changes in the ecosystems on which humans depend. Socioeconomic and institutional factors represent the indirect drivers. Although Díaz *et al.* mention that tax havens channel funds to support illegal fishing (1), they do not sufficiently emphasize the systemic role of investments in capitalist society.

Almost all provisions of food, feed, and raw materials, as well as socioeconomic and institutional changes, happen within the structural constraints and incentives of capitalism (2), a system based on private property, the competitive search for profit, and the reinvestment of profits. This system is extremely productive, generating enormous amounts of wealth, estimated at US\$360 trillion in 2019 (3). However, the laws of competition demand that this wealth be reinvested somewhere to yield a return, a fact that can have striking environmental consequences. The investment decisions of a small number of financial intermediaries are responsible for substantial changes to the Amazon and boreal forests biomes (4). In addition, wealth is distributed very unequally (5). The investments of individuals with a high net worth have a disproportionately large impact on the expansion of cropland in the Global South (6). These considerations raise two fundamental questions: If we succeed in finding investment opportunities for the global wealth, what will the ecological consequences be? And if we fail, what will the economic consequences be? At this point, greater attention should be paid to the nexus between wealth generation, investment, and environmental degradation in terms of both research effort and policy initiatives.

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Response

We agree with Ceddia that investment can play a key role in achieving the transformative change that is necessary to reverse nature's ongoing decline. In our Review, we pointed to the large impact of extractive industries, the unequal distribution of wealth associated with trade flows, and the handful of transnational corporations that control the majority of supply chains in agriculture, fishing, logging, and mining. Changing investment in these sectors can profoundly affect the future of nature.

More broadly, the impact of both public and private investment deserves more visibility (1, 2). It is also important to focus on the role that public policy and public opinion (including a more holistic view of economics and quality of life) can have in shaping investment (3, 4). A new economic system should build on and enhance the fabric of life rather than erode it. By rewarding actions that promote sustainability and penalizing actions that result in environmental deterioration, policies and attitudes can create powerful incentives for change in global financial and economic systems toward this vision.

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