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The Braskem case in Maceió, Alagoas: socioenvironmental issues with historical, ethical, and philosophical implications for geoscience education and outreach

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Abstract

Braskem is one of the world's largest petrochemical corporations and among Brazil's most profitable companies, operating for decades in the city of Maceió, state of Alagoas, in northeastern Brazil. Beginning in the 1970s, Braskem conducted halite mining in Maceió, which culminated in 2018 in one of the most severe socioenvironmental crises in recent history: ground subsidence across five neighborhoods within a 3.6 km^2 area, directly affecting approximately 60,000 people. Since then, specialized literature has produced a range of analyses of the event and its socioeconomic consequences; however, none have focused on the historical, geoethical, and philosophical implications for geoscience education and science communication. Drawing on primary Brazilian sources, most notably the Parliamentary Inquiry Commission's final report on Braskem and video recordings of its hearings, we (i) develop theoretical discussions concerning the role of the geosciences in the world informed by decolonial conceptions of science, and (ii) offer practical recommendations for curricula and science-art pedagogies that

cultivate a more critical geoscience, attentive to our deep interrelations with planet Earth. From a history-and-philosophy-of-science perspective, the Braskem case in Maceió enables reflection on conceptions of history, nature, and the philosophy of science, and – through case study analysis – expands dialogue about how sciences, particularly the geosciences, are defined and operate in ways that can both mitigate and exacerbate socioenvironmental and socioeconomic inequalities. Between theory and practice, we also reflect on the subjective responsibilities of geoscientists, science communicators, and institutions in confronting the destructive logics of scientific and technological development entangled with death politics, colonialism, and capitalist patriarchy, with historical, ethical/geoethical, and philosophical implications for the geosciences at global scale.

Keywords: Geosciences, Science education, Science communication, Braskem, Geoethics.

1. Introduction

Braskem, one of the world's most powerful corporations, caused ground subsidence across five neighborhoods of the city of Maceió – Pinheiro, Mutange, Bebedouro, Bom Parto, and Farol –, state of Alagoas (Maceió-AL), in northeastern Brazil, directly and adversely affecting approximately 60,000 people. This event constitutes one of Brazil's most severe socioenvironmental crises, with profound material and symbolic consequences for living and non-living entities (Vassileva et al., 2021; Manhas, 2022; Fontana et al., 2023; Hartwig et al., 2023; Santos et al., 2024; Lima et al., 2025; Owsiany and Lopes, 2025).

From a historical perspective, the environmental crisis caused by Braskem did not begin in 2018 but is grounded in a centuries-long process characterized by European invasion (colonialism) on the one hand and, on the other, the consolidation of an industrial-scale development agenda that began in the 1970s in Maceió and is embedded in the memory of a colonial world-system oriented toward extractive capitalism (see, e.g., Quijano, 2005; Nascimento, 2024). However, for coloniality we stand for the persistent, systemic legacy of colonialism in contemporary societies even though the historical colonialism has ended (Quijano, 2005).

From a geoethical standpoint, the subjective relations (among geoscientists, politicians, and managers) and institutional relations (among public and private bodies) in the Braskem-Maceió case – which shape interpretations of colonialism, capitalism, and patriarchy (masculine domination) – must be problematized, highlighting the hierarchical power relations inherent in the ways modern and contemporary science and technology are structured globally (Quijano, 2005; Rosa et al., 2020).

From a history-and-philosophy-of-science perspective, the Braskem-Maceió case prompts reflection on concepts of history, nature, and the philosophy of science (Matthews, 2013; Moura and Guerra, 2016; Alves-Brito and Macedo, 2022). Case-based inquiry broadens dialogue and understanding of how the sciences – particularly the geosciences – are conceptualized and practiced: while they can help mitigate inequalities, they may also contribute to the reproduction and deepening of socioenvironmental and socioeconomic disparities. At the same time, it is important to recognise that the geosciences are not a homogeneous field defined solely by colonial and technocratic logics. We recognize that there is also institutional, epistemological, and political heterogeneity within geoscientific practices and communities. Nevertheless, geoethics has emerged as a fundamental discipline, an era where human activities are recognized as a "geological force" capable of significantly and often irreversibly altering the Earth system (Peppoloni and Di Capua, 2017; Peppoloni et al., 2019; Vasconcelos et al., 2023). The field bridges the gap between the geosciences, sociology, and philosophy, providing a conceptual substratum to orient geoscientists and society toward responsible behaviour (Peppoloni and Di Capua, 2017; Ruchkys et al., 2020). Unlike traditional environmental ethics, which often prioritize the biotic world, geoethics highlights the intrinsic value of the abiotic environment (the geosphere) and the specific role of the geoscientist as a mediator between the planet and Society (Peppoloni and Di Capua, 2016; Vasconcelos et al., 2023). It advocates for a "responsible anthropocentrism", where humans assume the role of the critical and rational conscience of the Earth system (Peppoloni et al., 2019).

We contend that, at a global scale, the Braskem-Maceió case is pedagogically significant. As climatic and socioenvironmental crises intensify (Tsing, 2019; Alves-Brito, 2025a), Earth science education and communication (including geology, geophysics, oceanography, atmospheric sciences, mining and petroleum engineering, environmental engineering, geography, and geodesy) remain major challenges. These challenges derive in part from colonialism as a violent process of erasure, domination, and usurpation that continues (coloniality) to impose rigid and destructive theoretical, methodological, and epistemological frameworks on the geosciences. In reworking the epistemic foundations and social relations of the geosciences, it is essential

to incorporate historical, ethical, and philosophical perspectives that foreground Black, Indigenous, *Quilombola* (maroon), and other historically marginalized urban and rural communities. Consequently, it is impossible to contextualize the socioenvironmental crises in the Americas without accounting for the effects of colonialism (Alves-Brito and Alho, 2022; Ferdinand, 2022; Alves-Brito, 2025a).

Critical geoscience education and science communication thus assume a central role in the present century, in which competing narratives about the planet's future proliferate – many lacking scientific basis and sustained by misinformation, random opinion, or market dynamics within a capitalist system. Large corporations and big tech also appropriate digital media and capital resources to disseminate profitable narratives, often supported by geoscientists and science communicators. The Braskem-Maceió case exemplifies how such networks operate.

From this vantage, we argue that the geosciences are essential not only for integrated, physical understanding of Earth system dynamics but, crucially, for enabling recognition of and engagement with the diverse relations among the beings that constitute the planet. Despite these stakes, geology and geophysics continue to face processes of alienation in education and communication, frequently biased by positivist, Eurocentric perspectives and oriented toward research agendas and capital relations of the Global North – reinforcing colonial, capitalist, and patriarchal systems that have endured for centuries. The Braskem-Maceió case discussed here is a notable example.

Our main research questions are: In what way can the Braskem-Maceió (AL) socioenvironmental case help us reflect, in the field of geosciences, on systems of oppression that have on a global scale, altered the lives of living and non-living beings? What didactic-pedagogical and communicational strategies can be used to confront these global forces? What are the responsibilities of individual geoscientists and scientific institutions in dismantling these systems of oppression?

Accordingly, the principal aim of this article is to use the Braskem-Maceió socioenvironmental case as a reference point to analyse and discuss historical, ethical, and philosophical issues, and to formulate theoretical-epistemological reflections with practical recommendations for geoscience education and communication, with emphasis on geology and geophysics, which is critical given the challenges the world faces from the perspective of the impacts caused by socioenvironmental issues.

Methodologically, our analysis draws on primary documents from the Braskem-Maceió process, most notably the Parliamentary Inquiry Commission's (PIC) final report on Braskem (PICFR-B)[1] and a recorded PIC hearing in which Senators took testimony

[1] Available at: https://legis.senado.leg.br/atividade/comissoes/comissao/2642/mna/relatorios (accessed 23 June 2026).

from geoscientists concerning the catastrophe[2]. We also rely on other scholarly works and documents addressing the topic (Vassileva et al., 2021; Fontana et al., 2023; Hartwig et al., 2023; Santos et al., 2024; Lima et al., 2025; Owsiany and Lopes, 2025) and the documentary *Cidade Rachada* (2021)[3]. This essay therefore constitutes a theoretically oriented study based on qualitative research (Creswell, 2008), analysing publicly available textual and audiovisual sources. It constitutes a theoretically grounded study based on qualitative research principles (Creswell, 2008), drawing upon the analysis of publicly available textual and audiovisual sources. The study emphasizes the critical and systematic examination of documentary evidence to elucidate the social phenomenon under investigation (the Braskem-Maceió case), including associated experiences, meanings, and interpretations. The objective is to generate knowledge through the analytical framework derived from the theoretical perspectives integrated herein.

Special attention is devoted to the ethical, historical, philosophical, and educational dimensions of the case through the following methodological procedures: (i) formulation of the research problem; (ii) selection of the documentary corpus; (iii) assessment of the authenticity, credibility, and relevance of the selected documents, with particular consideration given to the institutions responsible for their production; (iv) exploratory reading of reports and repeated viewing of audiovisual materials, followed by transcription of the most relevant excerpts for inclusion in the article's analytical corpus; (v) coding and organization of data according to the broader analytical categories adopted in the study, emphasizing historical, ethical, and philosophical issues and their implications for geoscience education and communication; and finally, (vi) interpretation and discussion of the findings.

We focus our analysis on the Braskem-Maceió case, examining in detail the roles of prominent Brazilian and British geoscientists who, according to primary sources, are implicated in the catastrophe. Based on these professionals' participation, we reflect on individual and institutional responsibilities of geoscientists and science communicators in confronting the destructive logics of a model of scientific and technological development historically tied to death politics materialized in colonialism and capitalist patriarchy, with ethical and philosophical implications for the geosciences globally.

We hope this article will inform undergraduate geoscience curricula worldwide and support the need for curricular reform and the creation of museum, artistic, and science-communication narratives that – through alternative frameworks

[2] Available at: https://www12.senado.leg.br/tv/plenario-e-comissoes/comissao-parlamentar-mista-de-inquerito/2024/04/ao-vivo-cpi-da-braskem-ouve-alvaro-da-costa-roberto-farias-e-vitor-bourbon (accessed 23 June 2026).
[3] Available at: https://www.youtube.com/watch?v=GIGWXdOqL_0 (accessed 23 June 2026).

and languages – expand notions of history, ethics, and philosophy in the field and promote different modes of relating to planet Earth. Inclusion of geoethics in higher education curricula is a key requirement to ensure future geoscientists can transfer a renewed respect for the planet's delicate balances to society (Peppoloni and Di Capua, 2016, 2017).

2. The Braskem-Maceió (AL) case

According to detailed information reported in the PICFR-B (2024), Braskem is one of Brazil's most profitable petrochemical companies. Present in four countries (Brazil, the United States, Mexico, and Germany), Braskem began halite mining in Maceió in the 1970s, initially to supply chlorine and caustic soda, although the company also produces polyethylene, polypropylene, and polyvinyl chloride resins and chemical feedstocks such as ethylene, propylene, butadiene, benzene, toluene, and solvents. Among mineral-extraction methods, halite mining yields the highest ratio of production scale to cost.

However, as a consequence of decades of excavation, Maceió experienced, in 2018, a seismic event that constituted one of the country's most severe socioenvironmental crises (Figures 1 and 2).

In accordance with the PICFR-B and with the hearings conducted by the Brazilian Senate with geoscientists and other stakeholders involved in the PIC-B (PIC-B hearings, 2024), the scientific evidence obtained through systematic analyses released in May 2019 by the Geological Survey of Brazil (SGB – *Serviço Geológico do Brasil*) conclusively demonstrated that subsidence in the neighbourhoods of Maceió was, in fact, associated with rock salt extraction in the region. To conduct these studies, the SGB assembled a high-level team of geoscientists, comprising more than 50 professionals, who employed a combination of geophysical methods, sonar surveys, and interferometric measurements. The team concluded that Braskem had carried out systematic subsurface exploitation for decades in the neighbourhoods of Pinheiro, Mutange, Bebedouro, Bom Parto, and Farol, with no effective concern for socioenvironmental and socioeconomic issues, thereby causing erosion (subsidence and ground collapse) and permanently affecting approximately 60,000 people.

In contrast to the independently conducted SGB studies, Braskem hired, in parallel and after the 2018 seismic event, a team composed of renowned Brazilian and foreign geoscientists. The company contracted five scientists, all with extensive technical and scientific experience and academic training at prestigious institutions such as the University of São Paulo (USP), Imperial College, the University of Edinburgh, and the University of California, Berkeley.

Figure 1. *Location of the city of Maceió, Brazil.*

Through the work of these five scientists, Braskem adopted the following position regarding the SGB technical report:

> […] *there are inconsistencies in the methodologies used in the preparation of the CPRM*[4] *Synthesis Report to explain the geological phenomena observed in the neighbourhoods of Pinheiro, Mutange, and Bebedouro, in Maceió. The report also indicates that soil properties influenced the extent of damage in the three neighbourhoods* (PICFR-B, 2024, pp. 253-254).

[4] The *Serviço Geológico do Brasil* (SGB) is internationally known in English as the Geological Survey of Brazil. The institution, which is linked to the Ministry of Mines and Energy (MME), uses the acronyms SGB or SGB/CPRM (*Companhia de Pesquisa de Recursos Minerais*, or Mineral Resources Research Company) to represent its activities.

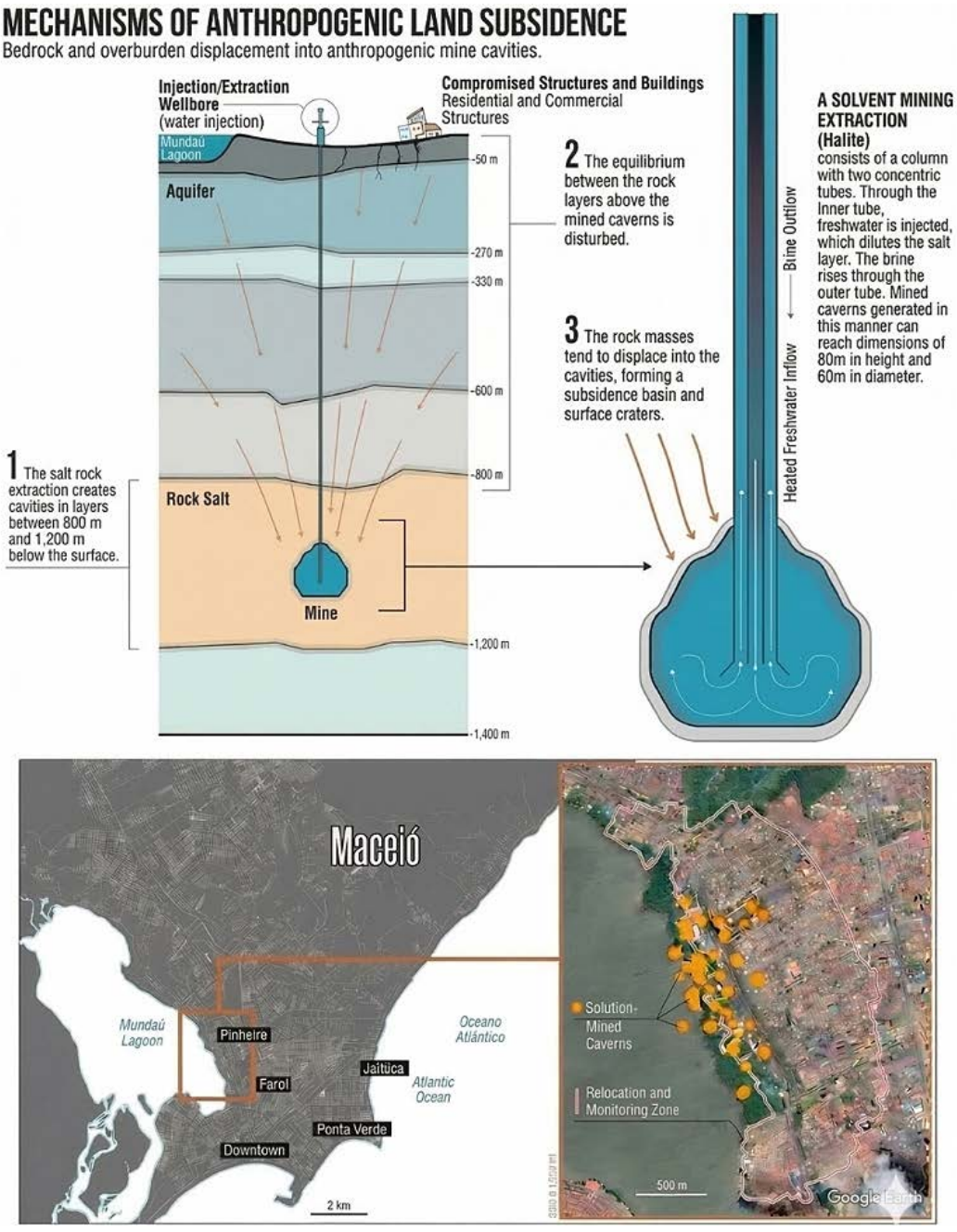

Figure 2. *Step-by-step representation of the soil subsidence process and rock salt extraction (top); map of Maceió highlighting the affected neighborhoods, mining sites, and areas of relocation and monitoring (bottom). Figure modified from Schmidt (2024).*

Clearly, the Braskem case in Maceió constitutes an interesting study from historical and philosophical perspectives (Matthews, 2013; Moura and Guerra, 2016; Alves-Brito and Alho, 2022). On the one hand, there is the detailed report produced by a Brazilian public company linked to the Ministry of Mines and Energy, grounded in a systematic research effort – both theoretical and field-based – that extended over several months and concluded that anthropogenic activity and Braskem's responsibility were central to the environmental crisis in Maceió.

On the other hand, there is the report commissioned by Braskem, which was signed by five geoscience professionals. Within 29 days, these geoscientists concluded that the orientation of the fissures in the analysed neighbourhoods was not compatible with rock salt extraction activities, as they argued that the data supported a natural origin[5] for the earthquake recorded in 2018.

In the PIC-B hearings (2024), the Parliamentary Committee's Rapporteur incisively questions. Many of the questions focus on how issues in the History, Nature, and Philosophy of Science (HNPS), more specifically on how science and scientific methods operate and on the ethical implications for geoscientists when conducting work with drastic consequences for the affected populations (PIC-B hearings, 2024: from 02:49 onward). The Rapporteur explains that, for the SGB to reach its conclusions, 15 million Brazilian reais were invested in a range of scientific experiments carried out in the region over nearly one year. In his remarks, the Rapporteur also stresses that data collection by the SGB was conducted by the agency itself and/or by companies contracted by it. In contrast, he emphasizes that the Braskem study cost the company five million Brazilian reais – equivalent to one million Brazilian reais for each contracted researcher – and further highlights that the dataset provided to these scientists was biased by the choices of the main party interested in weakening the final SGB assessment – Braskem itself:

> […] *In my opinion, professor, it is reckless to challenge a study based on primary data collected by those who conducted the research, using data provided by the company that requested that the study commissioned by the SGB, in the contract itself, president, be used to challenge the study carried out by the SGB. Therefore, it is an act of recklessness* […]. (PIC-B hearings, 2024, 02:12:07).

It is worth noting that Article 69-A, §2 of the Brazilian Environmental Crimes Act (LCA, Law No. 9, 605/98), mentioned in the PICFR-B, provides for an increased penalty (from one-third to two-thirds) for individuals who commit the crime of preparing false or

[5] Available at: https://www.tnh1.com.br/noticia/nid/braskem-divulga-novo-laudo-cprm-tirou-conclusoes-precipitadas-e-tremor-de-terra-teve-causa-natural/ (accessed 23 June 2024).

misleading environmental reports and/or assessments when, as a result of the use of such information, significant environmental damage occurs. In other words, although the five geoscientists hired by Braskem to challenge the SGB report were not indicted by the Brazilian justice system, they became entangled in the case in a highly complex way, with their academic and scientific trajectories being compromised. In this sense, some of the questions addressed to the witness, Marcelo Sousa de Assumpção, are particularly pedagogical and will be further examined later in this text.

3. Historical, ethical, and philosophical issues in the Braskem case in Maceió, Alagoas

3.1. Historical issues

It is difficult to reflect on the Braskem case in Maceió, Alagoas, as analysed here, without revisiting fundamental historical issues embedded in the very construction of modern and contemporary science and technology, which have immediate consequences for the region where the city of Maceió is currently located.

Frantz Fanon, Aníbal Quijano, Achille Mbembe, Françoise Vergès, Malcolm Ferdinand, and Linda Smith are Black and Indigenous intellectuals who have helped us reflect on the role of colonialism in the world and, in particular, on the violent and hierarchical relationships of being, knowledge, and power (Quijano, 2005; Smith, 2018; Vergès, 2023) that have been consolidated in what we now call Latin America – a term that is itself widely problematized in the literature (Mignolo, 2007). The convergences among these thinkers, writing in different historical moments, frame colonialism as a perverse historical system of political, economic, and cultural domination, perpetrated by one nation (the colonizers) over other peoples (the colonized), exploiting their material and symbolic assets and imposing, through enslavement, policies of domination and death (Mbembe, 2018; Smith, 2018).

The construction of modern and contemporary sciences and technologies, and in particular the Exact and Earth Sciences (Rosa et al., 2020), is a key component of the colonial world-system, which relegates subalternized bodies (Black, Indigenous, *Quilombola* communities, among others) to disadvantaged positions, following destructive logics grounded in social markers such as race, class, and gender (Smith, 2018; Vergès, 2018; Alves-Brito, 2024, 2025b). The colonial system – and its effects were not extinguished in historical processes of formal decolonization, a condition we refer to as coloniality (Quijano, 2005; Vergès, 2018; Smith, 2018) – is materialized and constantly updated in everyday life, often supported by hegemonic

discourses of scientific and technological development, the imposition of values, and the unrestrained exploitation of (agricultural and mineral) resources, in which enslavement (and its associated racism) operates as a fundamental technology to ensure the functioning of the colonial system and its social, cultural, and ethical logics at the heart of coloniality. Deep social, economic, and regional inequalities in the Americas and on the African continent are not "natural" facts, but historical, social, and political constructions. In this sense, it is necessary to build pedagogical processes in the Exact and Earth Sciences that work towards the decolonization of their theories and practices.

In Brazil in particular, regional inequalities (North/Northeast/Central-West versus South/Southeast) are also connected to the fact that our present remains saturated with a colonial past. Frantz Fanon (1925-1961), one of the major intellectuals of the twentieth century, calls for the decolonization of both thought and practice. The people affected by the Braskem case in Maceió, Alagoas, are, to some extent, an echo of what Fanon describes in *The Wretched of the Earth*, which urges us to reflect on this condition (Fanon, 2022). The historical archives of memory evoked by the Braskem case in Maceió, Alagoas – which recall and prevent forgetting – also bring to the fore subjective and institutional processes whose predominant logic is the expropriation and dehumanization of certain bodies deemed disposable (Smith, 2018; Mbembe, 2018; Fanon, 2022; Ferdinand, 2022; Vergès, 2023; Alves-Brito, 2025a).

Within the colonial world-system, the *plantation* was a key model of metropolitan exploitation applied to the colonies (Ferdinand, 2022). In this production platform, mercantilist and colonialist extractive economics formed its core, involving large landed estates (latifundia), the production of a single commodity (monoculture), and the enslavement of Black and Indigenous peoples. The plantation model underpinned the economy of colonial Brazil and also of other American countries colonized by Europe. In this respect, the city of Maceió is no exception. Historically, it maintains a deep relationship with the plantation system, in which sugarcane monoculture formed the basis of production.

In this sense, it is not an exaggeration to state that the contemporary mining industry is grounded in a colonial idea of extractivist mining, in which development schemes have been brutal toward Black, Afro-Brazilian, Indigenous, riverine, traditional, and also urban and rural communities subalternized by colonial narratives. The colonial world-system implanted with the European invasion remains renewed and aligned with the patriarchal capitalist system at the core of relations of being, knowledge, and power (Quijano, 2005) that large industrial conglomerates such as Braskem maintain with the planet. Moreover, it is impossible to disentangle the agencies and legacies of the colonial world-system from the ways in which modern and

contemporary sciences and technologies have been constructed. Braskem's drive for profit maximization, with little concern for the socioenvironmental impacts produced in local ecosystems (PICFR-B, 2024), is a direct outcome – on macroscopic industrial scales – of the same impulse toward the deterritorialization of human, non-human, and extra-human beings of the Earth, linked to the history of colonial barbarity worldwide (Smith, 2018; Ferdinand, 2022).

Consequently, the Braskem case in Maceió, Alagoas, prompts us to reflect on the necessary movement toward decolonizing the processes of knowledge production and professional practice in science, as well as the work of scientists and science communicators (Alves-Brito et al., 2020; Alves-Brito and Macedo, 2022; Alves-Brito and Alho, 2022). It is symptomatic, and not coincidental, that the five renowned scientists involved in the Braskem-SGB dispute are all men, perceived as white, heterosexual, and cisgender, well-positioned in prestigious global scientific institutions, and very well paid by Braskem, while a large portion of those affected by the environmental crisis in Maceió are subalternized within the historical narratives of geoscience and, in many cases, remain underserved by education, health, housing, and cultural policies. In this context, constraints on intellectual freedom and the influence of political or economic pressures may have compromised the ability of those five geoscientists to remain fully impartial and to exercise the ethics of responsibility, resulting in a cursory assessment of the subsidence crisis and contributing to reduced trust and protection for affected communities (Peppoloni and DiCapua, 2017; Peppoloni et al., 2019).

Braskem's extractive practices therefore cannot be decoupled from the prevailing logic guiding the development of mining-extractivist sciences and technologies in the service of European white enrichment – and of contemporary systems of whiteness[6] (Bento, 2022; Ferdinand, 2022; Alves-Brito and Macedo, 2022; Alves-Brito and Alho, 2022; Vergès, 2023; Alves-Brito, 2025b) – within the colonial system, in which practices of death (genocides and/or death politics; Mbembe, 2018) are normalized and continuously imposed on subalternized populations in Latin America and, more specifically, in Brazil's Northeast, as well as on other living and non-living beings on planet Earth (Ferdinand, 2022).

In this regard, we reaffirm in this text that racism – embedded in the fabric and social structure of the colonial world-system and, in particular, of the Brazilian system

[6] Whiteness studies, which have become prominent in the history of science from critical perspectives, are part of the social sciences and seek to examine in detail how positions of power and the distribution of material and symbolic privilege and prestige are occupied and enacted by white people within racist systems. The silence of geoscience researchers in Brazil regarding the Braskem case can be interpreted as a tacitly established agreement that reflects the symptom of whiteness, which the Brazilian scholar Cida Bento terms the "narcissistic pact of whiteness" (Bento, 2022).

(Alves-Brito and Alho, 2022; Alves-Brito, 2025b) – is a social technology of colonialism (Quijano, 2005; Ferdinand, 2022). From the standpoint of the historical-geographical, political-pedagogical, and epistemological panorama of antiracist education in *Améfrica Ladina* (Alves-Brito, 2025b), the Braskem case in Maceió, Alagoas, represents a striking and profound materialization of institutional and environmental racism, dramatically affecting human, non-human, and extra-human beings, in a renewed enactment of past colonial logics (Ferdinand, 2022) and, therefore, of a colonial and patriarchal capitalism, in which systems are predominantly controlled by white, heterosexual, cisgender men.

The historical-institutional implications of the Braskem case in Maceió, Alagoas, as grounded in the theoretical frameworks adopted in this article and in the PICFR-B, can be summarized in two main points. First, the relationships between the State and large (inter)national corporations in Brazil exhibit colonial and patriarchal capitalist features, characterized by dynamics of exploitation and profit-seeking. Second, without the legal support of municipal, state, and federal institutions, and without the technical backing of geoscientists trained in prestigious public and private institutions – many of them marked by colonial legacies in knowledge production – the legal and procedural developments would hardly have culminated in the negative impacts observed on populations and on living and non-living beings in Maceió (Vassileva et al., 2021; Hartwig et al., 2023; Fontana et al., 2023; Santos et al., 2024; Owsiany and Lopes, 2025; Lima et al., 2025).

The historical-epistemological implications are evident in the fact that this environmental crisis also contributed to the erasure and destruction of ways of being and living in affected territories that do not appear within hegemonic cartographies of science. Archives of memory – especially Black, Afro-Brazilian, and Indigenous, both urban and rural – as well as architectural and intangible heritage, were destroyed (Rosa et al., 2020; Manhas, 2022; Owsiany and Lopes, 2025; Alves-Brito, 2025a).

The historical-environmental implications are corroborated by the fact that a large portion of those affected by ground subsidence in Maceió are predominantly racialized bodies within the colonial world-system. White individuals occupy most positions of power (inside and outside Braskem) and, in general, do not experience the most severe consequences of the socioenvironmental crisis attributed to the company. Beyond human populations, ecosystems – living and non-living – were also affected: fauna, flora, buildings, and architectural assets of material and symbolic value for the memory of Maceió, among others (Manhas, 2022). In his critical essay, Ferdinand (2022) explores the multiple ways in which the plantation and socioenvironmental crises have articulated colonial and environmental fractures. The Braskem case in Maceió, Alagoas, is a canonical example of how these logics operate insidiously within global cartographies.

These three historical dimensions reaffirm the longstanding inclination of the mining industry toward ecosystem destruction, continually revalidating and reappropriating civilizational ideas and principles materialized in the colonial world-system. Mining activities in Latin America from the fifteenth to the seventeenth century are closely tied to the consolidation of a global capitalist and patriarchal agenda. As Figueiredo (2011), when discussing how seventeenth-century gold-mining expeditions in Brazil were carried out, confirms:

> *The environmental impact caused by this predatory human mass soon led to a shortage even of the "filthy animals" in the mining areas. Once again, it is the governor-general who reports the case: "When these [**animals**] were no longer available to sustain their lives, they abandoned the mines and fled into the forests with their slaves, surviving on the wild fruits they found there"* (Figueiredo, 2011, p. 138, our emphasis).

3.2. Ethical issues

The ethical issues in the Braskem case in Maceió, Alagoas, are both individual/subjective and institutional. At the individual level – of particular interest to our discussion here – they invite reflection on how five prestigious geoscientists, within their academic and professional communities, became implicated in the production of a technical report that, according to the PICFR-B's conclusions, was prepared to serve Braskem's interests. This is a serious ethical matter that should be used to foster theoretical and practical debate in the initial education of geoscientists and science communicators, as well as critical reflection on their theoretical-practical and political engagements in the world.

Throughout the hearings (PIC-B hearings, 2024), the Parliamentary Committee's Rapporteur made several comments directed at Prof. Marcelo Sousa de Assumpção that prompt deep reflection on (i) ethics in science; (ii) what science is; and (iii) how science is constructed (its methods and rigor) and for what/whom it serves, in terms of its ethical and social uses and commitments. At various points in the Rapporteur's remarks, the witness, geophysicist Marcelo Sousa de Assumpção, is ethically challenged. For example, when referring to the conclusions of the study conducted by the witness and his colleagues in 2019, the Rapporteur states:

> *It is correct to observe that large-amplitude surface waves suggest a shallow focal depth for the main 2018 earthquake. The term "shallow" was not qualified – 100 m, 1 km – but this is not sufficient grounds to conclude that the earthquake*

> *was induced, since natural earthquakes can also be shallow, with a focus less than 1 km deep. The process of mine instability cannot be ruled out, but it is not possible to associate it, given the great depth, with the intense deformations observed at the surface. On the other hand, any potential instability process may be halted by the known thick conglomerate layer or by horizontal stresses in the rock mass* (PICFR-B, 2024, p. 763; PIC-B hearings, 2024; 02:16:24).

Still dissatisfied, the Rapporteur goes on to comment on the conclusions of another study carried out by the five geoscientists hired by Braskem, approximately one year after the first study:

> *The event of increased pressure leakage from the caverns and the resulting movement along faults, especially those located within the salt, triggering their reactivation, makes the occurrence of cavern instability possible. This instability was not explored in this analysis. This conclusion is based on an assessment of the displacement of the energy dissipated along the faults. The increase in energy resulting from the leakage of pressurized brine from the caverns, dissipated along the salt faults and in the portion that penetrates the sediments, is significant and may account for the occurrence of earthquakes. The relative importance of the direct effects of mining and the worsening of surface conditions still cannot be accurately assessed in the region immediately adjacent to and above the mines. The high subsidence – about 50 centimeters over three years – observed at the surface can be explained by several factors, such as the collapse of caverns in soluble layers within and above the salt. However, some complex geomechanical models, including the interaction of soluble layers with local faults and high neotectonic stresses, may potentially account for the subsidence observed in Mutange and possibly the horizontal displacements measured in Pinheiros* (Rapporteur, 2024; PICFR-B, p. 763; PIC-B hearings, 2024; 02:17:19).

As stated in the PICFR-B and also observable in the video recordings of the hearings:

> *The witness was questioned about the changes that occurred between 2019 and 2020 that would justify significantly different statements, based on the same datasets, as presented in those conclusions. He replied that, at the time of the report, there were several different hypotheses that could be used to explain the subsidence and cracking in the Pinheiros neighborhood. As studies progressed and the earthquakes and subsidence were analyzed, the consultants began to realize that movement within the salt layer was the most likely hypothesis* (PICFR-B, 2024, p. 763).

Regarding the fact that the five geoscientists based their analyses on data provided by Braskem, the geophysicist Marcelo Sousa de Assumpção responded to the committee's rapporteurs by stating that he and his colleagues had no reason to doubt Braskem's honesty. In fact, the fundamental question underlying the discussion during the hearings can be summarized as follows: how could researchers with extensive professional experience (technical, scientific, and academic) have trusted data produced by the very same company that, in practice, had the greatest interest in discrediting the SGB's opinion, which had been produced in a detailed and fully impartial manner?

At the institutional level, Braskem was held responsible for the rock salt extraction that exacerbated socioenvironmental issues through the subsidence of neighbourhoods in Maceió. The human, non-human, extra-human, moral, and material damages – such as cracks in buildings, collapses, evacuations, the abandonment of historical buildings, and collective moral harm – were extensive. Throughout the PICFR-B, it was demonstrated that there were intentional failures in the oversight of Braskem's activities by public agencies at the state and other levels, which constitutes another serious ethical dimension of the case. Historically, Brazil's National Mining Agency allowed Braskem to conduct its operations. Public authorities did not react, at first, as they should have, given that Braskem opened two mines in mangrove areas, which represents a major environmental contradiction. From a scientific standpoint, urban subsidence in Maceió is also a unique case worldwide.

Moreover, the legal agreement that provided for reparations to affected families was not fulfilled as it should have been. Of the 30 billion Brazilian reais estimated by the Brazilian government for victim compensation, only 1.2 billion Brazilian reais was actually paid by Braskem[7]. In short, people lost their homes and businesses, suffering irrecoverable material and symbolic losses. The logic of profit, which underpins the model of colonial and capitalist "sustainable development," deepened the ethical issues in the Braskem case in Maceió, Alagoas. The role of the Federal Public Prosecutor's Office, however, should be highlighted as exemplary in securing minimum rights for those affected.

In addition, Lima and Rodrigues (2025) recently analysed the impact of the Braskem environmental crisis on the health of residents in the Maceió neighbourhoods affected by ground subsidence. The results indicate that the disaster affected people's mental health, with numerous reports of stress, anxiety, and depression. The study showed that reported mental disorders in the population were also correlated with the prevalence of systemic arterial hypertension. It is worth noting

[7] Available at: https://agenciabrasil.ebc.com.br/direitos-humanos/noticia/2025-11/vitimas-de-afundamento-de-solo-criticam-acordo-entre-braskem-e-alagoas (accessed 24 June 2026) (in Portuguese).

that this fragile health scenario, in the aftermath of an anthropogenic seismic event, is once again intertwined with racism (a technology of colonialism), since, from a global perspective, we have argued that racism must also be analysed and treated as a serious public health issue[8].

An additional ethical concern pertains to the conduct of the geoscientists hired by Braskem to contest the SGB report: given the case's status as one of Brazil's most severe socioenvironmental crises, the contrast between the independent SGB investigation (an interdisciplinary team linking subsidence to rock-salt extraction) and the corporate-funded studies underscores the geoethical stakes. By relying primarily on company-provided data, failing to fully disclose limitations and potential conflicts of interest, and producing conclusions that appear to align with corporate interests, these consultants risked compromising intellectual freedom, professional integrity, and transparency – core obligations under the ethics of responsibility. Such constraints on autonomy diminish the capacity to present scientifically valid, unbiased scenarios for decision-makers, erode public trust, and hinder the geosciences' duty to serve society and the Earth system (Peppoloni and Di Capua, 2017; Peppoloni et al., 2019).

3.3. Philosophical issues

As already noted, the Braskem case in Maceió, Alagoas, also raises situated discussions on issues in the HNPS. For example, at a certain point in the exchange between the witness, geophysicist Marcelo Sousa de Assumpção, and one of the PIC-B rapporteurs, the Rapporteur claims that the room for questioning in the natural sciences is very narrow. This remark is made as the Rapporteur seeks to challenge the witness's argument about the reasons that led him and his colleagues to reach different conclusions in reports submitted roughly one year apart.

For the Rapporteur, questions arising from precise mathematical models leave very limited margins for arriving at such distinct conclusions about the same problem, especially when dealing with the same dataset. In his response, Prof. Marcelo Sousa de Assumpção disagrees with this provocation, stating that many geophysical surveys are interpreted differently by different groups of scientists. By way of example, the witness notes that the SGB concluded, in its report, that the detected earthquake was shallow and therefore considered it to be an induced event, which he regards as controversial (PIC-B hearings, 2024, 02:14:40; PICFR-B, 2024, p. 763).

[8] Available at: https://prismreports.org/2025/12/03/health-justice-fascism-equalhealth/ (accessed 23 June 2026).

After the witness's intervention, the Rapporteur takes the floor and states that the geophysicist's conclusion cannot be correct, because it was not based on a more detailed geological study of the subsurface. At this point, appealing to the authority of scientific expertise, the witness asserts that he has 50 years of experience in geophysics, and is forcefully interrupted by the Rapporteur:

> […] *In this setting, the authority of time does not count.* […] *The authority lies in what is written. It is the study that was carried out, not your authority as a 50-year researcher. If you included a certain content in the report, that is what we will rely on, not on your 50 years of experience. You are not being correct. You are abusing your 50 years of experience to try to shift the focus. The focus here is the report, in which you did not take into account the geological study of the area from the 1980s. There is no mention whatsoever of this geology of the terrain* (PIC-B hearings, 2024, 02:15:19).

From the perspective of the HNPS, the discourse of scientific authority is one of the major barriers to establishing horizontal dialogue between scientists and non-scientists. Collins (2015) historicizes this issue by arguing that, after World War II, the authority of scientists and of scientific discourse was significantly strengthened in society. The debate on *scientific authority* between the witness and the Rapporteur in the Braskem case in Maceió, Alagoas, also raises questions about how science should be constructed. In general, *authoritarian scientific discourse* reinforces *internalist views* (models, methods, logics) of the historical construction of science, leaving little room for *externalist perspectives* (social, cultural, economic, and political issues) to be considered (Matthews, 2013; Moura and Guerra, 2016). Contemporary critical approaches in the history of science argue that both *internalist* and *externalist* dimensions must be considered (Moura and Guerra, 2016; Alves-Brito and Macedo, 2022).

Contemporary science should not be conceived solely as a linear trajectory of theoretical replacement, in which earlier forms of knowledge are simply devalued. Such a conception contrasts with positivist traditions that privilege a normative sequence of statements and reintroduce the idea of a single, prescriptive scientific method – almost as a "recipe" – whose strict application legitimizes the authority of specialists in the field (Moura and Guerra, 2016).

In the Braskem case in Maceió, Alagoas, those affected by the unfolding environmental crisis were never invited to discuss solutions or to critically examine how scientific knowledge about the region was historically constructed. By hiring five prestigious geoscientists to refute the technical-scientific report produced by a public company, supported by a broad professional team and multiple in-situ

experiments and surveys, Braskem sought to construct a biased scientific narrative that disregarded both the existing scientific record on the region and the accumulated knowledge (experience) of the local population. Furthermore, Braskem's discourse, voiced through its geoscientific consultants, reinforces the rhetoric of neutrality in scientific observations and experiments – a dangerous stance (Moura and Guerra, 2016; Alves-Brito and Macedo, 2022).

Likewise, when the public agency SGB hired more than 50 professionals to support its report, it reinforced the conception of science as a collective endeavour (Moura and Guerra, 2016). There was an explicit concern with reducing bias and with reproducing, through models, the natural and artificial conditions of earthquake generation, thereby emphasizing the centrality of modelling in contemporary scientific processes. Conversely, the hiring of five prestigious scientists to refute a *collective report* reinforced not only the notion of *scientific authority* but also that of *scientific genius*, which has been increasingly called into question, particularly in light of ongoing efforts to humanize scientific practices and to promote diversity of voices and perspectives in the construction of modern and contemporary science and technology (Moura and Guerra, 2016; Alves-Brito and Macedo, 2022).

Another key HNPS issue that can be expanded from the Braskem case concerns how the technical apparatuses used by both groups (Braskem and SGB) served to empower (or weaken) the theses advanced in each report. The PICFR-B indicates that Braskem intentionally and selectively produced data, without prioritizing technical apparatuses that would have allowed the five geoscientists to reach robust conclusions. *Scientific objectivity*, a cornerstone of the hegemonic conception of modern and contemporary science, is thereby compromised. Between subjectivities and objectivities, there is an irrefutable fact in the Braskem case: thousands of beings, living and non-living, were affected in Maceió, Alagoas, as a result of the company's systematic activities on Brazilian soil.

From decolonial perspectives, dialogue between scientists and non-scientists must be actively fostered. The construction of scientific consensus and the development of solutions to problems created within science and technology themselves must be pursued through sustained dialogue between the *scientific community* and the *broader public*. In the Braskem case in Maceió, Alagoas, there was, at no point, any meaningful dialogue between Braskem and the human, non-human, and extra-human contexts of the affected region. We argue that science and technology should not be developed apart from the social, cultural, and political contexts in which they are embedded, because it is impossible to separate science and technology from the lived realities of people and of other beings that constitute ecosystems. The "texts" and "contexts" of relations between the *worlds of science* and the *worlds of everyday life* must be taken into account by the geosciences. Sustainability on

planet Earth will not be achievable unless active, sensitive listening is carried out in the territories where science and technology alter localized ways of being and living – in other words, *buen vivir* (good living).

From the standpoint of HNPS, the Braskem case in Maceió, Alagoas, also allows us to problematize the political meanings behind research questions and practices, and to ask who the people, groups, and/or non-living entities implicated by them are. In the scientific dimensions of the Braskem case, there are clearly individuals and groups who profited greatly from its unfolding (Braskem, governmental and private institutions, geoscientists) and those who were, in fact, severely harmed (the affected communities, both living and non-living). The disturbing outcomes of the Braskem case in Maceió, Alagoas, make it clear that there was no real concern, at any stage of the research processes, for the living and non-living beings that constitute the landscape of Maceió.

As is explicitly questioned in the PICFR-B records, how is it possible that researchers with long experience in scientific methods and procedures could have trusted, uncritically, a company like Braskem – especially when the scientific data it provided would benefit the company itself and harm the population of Maceió? (PIC-B hearings, 2024; 02:12:35).

4. Implications of the Braskem case in Maceió, Alagoas, for geoscience education and outreach

It is therefore worth asking: in what ways can undergraduate and graduate programs, as well as geoscience outreach spaces, contribute to the ethical training of professionals and to the critical positioning of the public regarding environmental impacts on planet Earth? How can the Braskem case in Maceió, Alagoas, help us rethink initial and continuing education, as well as geoscience outreach in Brazil, with global implications? These are fundamental questions that, in our view, have not been discussed as they should in Earth science programs.

Educating future geoscientists in geoethics is considered a key requirement to ensure they can transfer a new way of respecting the planet's delicate balances to societies (Peppoloni and Di Capua, 2016, 2017). Research shows that students often begin with limited knowledge of geoethics, but case-based instruction is highly effective. Vasconcelos et al. (2023) adopted a case-based approach to engage learners with real events, cases, and dilemmas, fostering discussion and the reassessment of positions, values, and principles. This pedagogy supported the development of competencies essential for the 21st century, such as critical thinking, collaborative problem-solving, and argumentation. In the study conducted

by Vasconcelos et al. (2023), all participants were introduced to geoethics, its connections to sustainable development, and a specific topic related to the Earth system. Interviewed students reported gains in geoethics knowledge across all topics, indicating a positive enrichment effect from the program; although specific competencies were not directly measured, the instructional materials and case-based pedagogy required students to exercise critical thinking, argumentation, and collaboration skills.

Internationally, The Erasmus+ Geoethics Outcomes and Awareness Learning (GOAL) project was a major international initiative that developed a comprehensive syllabus and educational resources for higher education (Vasconcelos et al., 2023). Every educational resource, along with the core curriculum, is specifically designed to emphasise the intricate connection between geoethics and sustainable development. The curriculum is structured around six core modules: (i) Geoethics: foundations, definition, meaning and values; (ii) Geoethics and Georisks; (iii) Geoethics and Geoheritage; (iv) Geoethics and Mining; (v) Geoethics and water management; (vi) Geoethics in Education. According to Peppoloni and Di Capua (2017) and Peppoloni et al. (2019), geosciences are essential for addressing major societal challenges such as climate change, resource and energy management, environmental sustainability, geo-hazard protection, and the development of a knowledge-based society. The social values guiding this vision are sustainability, prevention, and education. Sustainability involves prudent long-term use of natural resources and reduced energy consumption: in the short term, strategies and technologies should decrease use of fossil fuels and increase renewable energy; in the long term, economic models must enable future generations to discover alternative energy sources and resource uses (Peppoloni and Di Capua, 2017; Peppoloni et al., 2019). Prevention requires an ethical focus on protecting populations from geo-risks and prioritizing resilience rather than solely emergency response. Geo-education, the transfer of geological knowledge to the public, enhances awareness of the Earth system and supports a knowledgeable society (Peppoloni et al., 2019). Ethically, geoeducation can bridge scientists, the public, and decision makers, increase trust in science, reduce social marginalization of scientists, and promote genuine knowledge-based development.

We also argue that educational frameworks, such as those that are discussed in Alves-Brito and Macedo (2022) and Alves-Brito and Alho (2022), are capable of operationalising our recommendations in this article. Thus, decolonial pedagogies, which consider other forms of dialogue between geosciences and societies, considering historical, philosophical, epistemological, and geoethical aspects, are crucial (Matthews, 2013; Moura and Guerra, 2016; Alves-Brito and Macedo, 2022; Vasconcelos et al., 2023). We argue that by using case-based teaching (like the

Maceió disaster), universities can train new geoscientists to handle real-world dilemmas where technical data must be balanced against social values (critical thinking). Future geoscientists must be trained to be aware of the limits of their own competence and to maintain intellectual honesty, preventing the "loss of credibility of Science" that occurs when professional roles are compromised by external interests (competence awareness). The Braskem-Maceió case illustrates that geoethics is not a limit to action, but an essential reference framework. Without it, the "geological force" of human activity can lead to irreversible damage to both the environment and the social fabric of entire communities.

In the context of higher education, undergraduate[9] and graduate programs in geology and geophysics, for example, are almost always focused on positivist and Eurocentric perspectives of science. These programs are fundamentally aligned with technicist views and with deep engagement with the market, neglecting theoretical and methodological discussions on cultural issues and/or sociotechnical conflicts that allow critical examination of hierarchical power relations among corporate and industrial actors (mining, oil, gas, geotechnics, civil engineering, geochemistry, geophysics, hydrogeology, among others), universities, and the interests of diverse social and community organizations (*quilombola* communities, Indigenous villages, Afro-Brazilian religious communities, peripheral neighborhoods, and other urban and rural subalternized communities). Research agendas in many graduate programs have devoted little attention to historical, sociocultural, and political dimensions of the territories under study. Uncritical and highly disciplinary technical training thus becomes a structural problem in the field.

Moreover, within basic education curricula in Brazil and in other countries of the Global North and South, there is no specific subject dedicated to discussing basic notions of geology and geophysics, although geography and general science, in dialogue with the natural sciences (physics, chemistry, and biology), partially fulfill this role. In this sense, we argue that higher education – especially at the bachelor's level and, above all, in teacher education programs – must expand and diversify its didactic-pedagogical, epistemological, and political approaches to socioenvironmental issues, explicitly addressing historical and ethical-philosophical dimensions in geoscience education.

It is also worth noting that Earth science museums have not been utilized to their full potential. Many of them remain overwhelmingly focused on the technical and

[9] Available at: https://www5.usp.br/ensino/graduacao/cursos-oferecidos/geofisica/ (Geophysics/USP); https://uspdigital.usp.br/jupiterweb/jupGradeCurricular?codcg=44&codcur=44011&codhab=100&tipo=N&print=true (Geology/USP); https://sigaa.ufba.br/sigaa/public/departamento/componentes.jsf?id=1147 (Geophysics, UFBA); https://sigaa.ufba.br/sigaa/public/departamento/componentes.jsf?id=1146 (Geology, UFBA); and https://www.ufrgs.br/site/ensino/graduacao/geologia/ (Geology/UFRGS) (accessed 23 June 2026).

content-heavy aspects of the geosciences, at times adopting a naively playful approach (Vergès, 2023; Alves-Brito and Nunes, 2024). We understand museums as strategic spaces to broaden scientific horizons and to foster the construction of dialogue between academic and non-academic worlds. On the one hand, this can strengthen processes of humanizing the Earth Sciences; on the other, it can raise awareness among different social groups about the socioenvironmental and climatic impacts of these sciences on the most vulnerable populations, understanding vulnerability not as a given biological condition, but as a result of historically constructed social and political processes. Vergès (2023) offers powerful pathways for decolonizing museums – particularly science museums – that defend and disseminate the idea of a "universal museum" which fails to question colonial narratives and contributes to the construction of an exclusionary national identity. We argue that geoscience curricula across both the Global North and the Global South can no longer be grounded in ostensibly neutral, atheoretical, and ahistorical approaches to knowledge production that obscure their entanglement with relations of life and death in anthropological and anthropo-logical terms. HNPS issues – especially in critical and externalist perspectives – must increasingly be incorporated into professional training in the field. Curricula should place greater emphasis on HNPS topics and episodes, offering clear examples of socioenvironmental and climate issues, environmental racism, and the (im)material heritage implications of planetary destruction.

The Braskem case in Maceió, Alagoas, has significant potential to catalyse discussion and to help students critically examine scientific knowledge and how it constructs "truths" in the world – truths that often operate through practices of dehumanization and the deepening of racism and classism within colonial logics (Rosa et al., 2020; Alves-Brito, 2025a, 2025b). The discourse of scientific authority, coupled with the notion that science is conducted by a select few who manipulate unquestionable truths constructed in a linear fashion (with a disconnected past, present, and future), represents a fragile premise for valuing and communicating science in the fight against fake news and other pseudo-truths that have been constructed around geo-logics.

The Braskem case denaturalizes historical practices of scientific construction that are treated as apolitical and devoid of intentionality. It also opens space to problematize effective ways of taking into account people's prior knowledge about the affected region.

Furthermore, the Braskem case provides an opportunity to examine how scientific consensus is constructed and what limits, if any, exist for divergent scientific groups to advance competing interpretations of the same dataset – without ignoring that none of these interpretations are pure, naïve, or free from political commitments. Classroom

teaching and museum narratives should both problematize how interpretations of scientific data emerge from the assumptions and experiences that each scientific group brings to the table and, more importantly, what impacts these knowledge practices have on the planet. In this regard, it is essential to conceive of collectivity as the most meaningful locus for the construction of scientific consensus, while simultaneously expanding and complexifying the very notion of collectivity.

Finally, the Braskem case in Maceió, Alagoas, reaffirms that ethical issues must not be absent from any scientific endeavour. The social and socioeconomic impacts of research findings must be carefully examined by scientists and institutions engaged in dialogue with society. Principles and values cannot be relativized when they severely affect the existence of living and non-living beings on the planet. Between theories and practices, there are subjective responsibilities borne by geoscientists and science communicators, as well as by institutions, in confronting the destructive logics of a conception of scientific and technological development aligned with politics of death – logics that have historical, ethical, and philosophical implications for the geosciences on a global scale. These responsibilities must be continually revisited and reaffirmed as a foundational principle for the critical exercise of scientific thinking and for the deepening of democracy. Table 1 summarizes the historical, ethical, philosophical, and educational dimensions of the Braskem case discussed in this article.

Dimensions	Description
Historical	Colonialism; capitalism; patriarchy; plantation; planetary degradation; social injustices.
Ethical	Geoethics; hierarchical relationships of being, knowing, and power; relationships between humans, non-humans, and extra-humans; limits and virtues of geoscientific practices; socio-environmental injustices; responsibilities of researchers and public and private institutions; geoscience-society interaction; intellectual freedom, professional integrity and transparency.
Philosophical	Epistemologies; ontologies; discourses of scientific authority; positivism; counter-hegemonic cosmologies.
Educational/ Communicational	Decolonial education; decolonization of geosciences and associated technologies; evidence-based science education and communication; critical thinking; counter-hegemonic curriculum; decolonial reparations and restitutions; decolonizing†practices of geoscientific communication.

Table 1. *Historical, ethical, philosophical, and educational/communicational dimensions of the Braskem case.*

5. Concluding remarks

In Brazil, Braskem's company is implicated in one of the most severe socioenvironmental crises in the country's history. Thus, drawing upon decolonizing conceptions of science, we recommend the development of non-Eurocentric curricula for the initial and continuing education of geoscience professionals. We advocate for the diversification of didactic-pedagogical, epistemological, geoethical and political experiences within the context of the geosciences. Such a recommendation is urgent in light of global strategies for disseminating fake news and defending private and institutional interests that threaten the existence of historically vulnerable groups, the most fundamental values of the geosciences, and life itself on the planet.

We suggest that universities, research institutions, and/or industry-focused organizations create dedicated training spaces and establish robust mechanisms for monitoring the ethical conduct of their professionals in relation to different knowledge systems, with respect for living and non-living beings and the preservation of life on Planet Earth as a foundational principle. It is necessary to expand, within higher education and basic education curricula, geoscience programs and projects anchored in the principles and values guided by the project of Education for Ethnic-Racial Relations. This entails understanding that ecosystems and world-systems are intersected by cosmological (philosophical) questions that are neither neutral nor devoid of economic interests. Market logics and training biased toward enriching a minority at the expense of planetary degradation must be questioned throughout professional training and practice. It is essential to ensure that Black, African, Afro-Brazilian, and Indigenous histories and cultures are globally integrated into geoscience curricula, and that issues of race, gender, language, geographic origin, and social inequalities become integral components of professional formation.

In the movements toward dialogue between geoscientists and societies, progress must also be made toward maximizing the potential for dialogue between the geosciences and other creative languages – audiovisual media, literature, photography, podcasts, exhibitions, installations, among others – and the potential of museological experiences. Practical actions aimed at proposing more critical curricula and scientific-artistic experiences within the geosciences, which take into account our profound relationships with Planet Earth, should be encouraged at all formative stages, in undergraduate and graduate programs.

Critical issues of HNPS must thus be taken very seriously throughout the training of geoscience students and science communicators. Scientists and science communicators must assume ethical responsibility for their professional choices and the impacts of their activities; ethical questions cannot be minimized.

A geoethical reflection on the Braskem-Maceió case highlights the professional and moral failings that may arise when intellectual freedom, transparency, and independence are constrained by corporate funding and conflicts of interest. The conduct of the five geoscientists contracted by Braskem – relying predominantly on company-provided data, insufficiently disclosing methodological limitations and potential conflicts, and producing conclusions that contrasted with the independent SGB findings – illustrates how violations of the ethics of responsibility (to self, colleagues, society, and the Earth system) can erode scientific credibility, diminish public trust, and produce harmful outcomes for affected communities. These issues must be explicitly addressed in higher education: curricula and professional training should integrate case-based instruction on intellectual freedom, conflict of interest management, full disclosure practices, and institutional oversight to prepare geoscientists to uphold geoethical standards in research and practice.

We recommend that public and private institutions strengthen their institutional performance by creating protocols and mechanisms to combat disinformation, ensure efficient personnel and logistics management, and guarantee the effective application of legislation, so as to hold accountable individuals and organizations implicated in the destruction of ecosystems.

Finally, we emphasize that critical and ethical training in the field of geosciences acquires a profound political dimension, as does the need to expand cosmological (philosophical) perspectives on Planet Earth. This is essential for the effective strengthening of educational, cultural, scientific-technological, and legal policies that enable us to make informed decisions regarding the impact of major (inter)national projects on the planet's beings (living and non-living). The three dimensions analysed – historical, ethical, and philosophical – carry implications for the construction of other language systems that need to be put into practice in the field of geoscience education and communication, with the preservation of living and non-living beings on Planet Earth as the utmost priority. This represents a significant challenge, but also a unique opportunity to construct other geo-logics. Between theory and practice, our main contribution is to reflect on the subjective responsibilities of geoscientists, science communicators, and institutions in confronting the destructive logics of scientific and technological development entangled with death politics, colonialism, and capitalist patriarchy. These global forces can be countered through the development of didactic-pedagogical and communicational strategies based on geoethical principles, as well as on counter-hegemonic theoretical and methodological apparatuses, such as decolonial education/communication initiatives at global scale.

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