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The influence of geoethics on the professional activity of the Earth sciences

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Abstract

The purpose of this study is to identify the challenges that geoscientists face in their professional practice concerning geoethics. It explores their perceptions, the tools available to them, and the significance of this concept in their professional activities. The research relies on semi-structured interviews conducted with Earth Science professionals who have developed their careers primarily in Argentina, and to a lesser extent in other regions. Although the term "geoethics" is not systematically addressed in academic institutions, professionals compensate for this lack of formal training with their own ethical values, in alignment with the protocols established by the companies or institutions that employ them. Furthermore, when ethical dilemmas arise, they often find themselves reconciling their personal values with corporate objectives, without the support of a geoethics code to guide them in cases of conscientious objection when consensus proves insufficient.

Keywords: Geoethics; Earth sciences; Extractive industries; Curriculum design

1. Introduction

In his analysis of what he describes as a "post-moral" society, Lipovetsky (1992) asserts that efficiency, in an era of great individualism, cannot be achieved without respect for humanity, that is, without a humanist dimension. This statement is particularly valid when analyzing the weight that applied ethics has in the geosciences, from now on referred to as geoethics. This study examines how Earth Science professionals perceive, and experience activities related to the exploitation of non-renewable resources, in relation to ethical values, both in the mining sector and in the petroleum industry, as well as in the general professional practice of geosciences. This exploratory work aims to analyze what happens in the professional practice of geosciences not only in Argentina but also in jurisdictions where the interviewees have worked: Brazil, the United States, Colombia, Uruguay, Peru, and Spain. It should be clarified that the objective is not to characterize how the geoscience profession is practiced in each geographic location but to delve into the often-divergent problems that geologists and engineers have to face. These professionals have worked during the exploration and exploitation stages in mining and petroleum, without excluding the less numerous cases in the sample of research in the field where ethical dilemmas are also at stake.

The practice of geoscience in mining or oil-rich areas involves a range of unusual challenges that are foreign to most professions. The work environments of the interviewees have often had extraordinary challenges, for example, working in mineral exploration in the Amazon rainforest, being subject to death threats and kidnapping by guerrilla groups intertwined with drug trafficking in Colombia, coexisting with drug cartel actors in Mexico, and working in the oil industry from the U.S. in wells located in Iraq in the early 2000s. These extreme cases share the stage with professionals who have worked in the emerging mining industry of Uruguay, and in the extremes of Argentina, from the Puna to Santa Cruz.

2. Methods

This is an exploratory study that investigates, through semi-structured questions, Earth Science professionals, including mining, petroleum, and drilling engineers. The method used is framed within the qualitative research paradigm employed in the social sciences, whose objective is to understand a phenomenon in depth.

Interviews are the resource that allows the interviewer to understand the world from the interviewee's perspective and break down the meanings of their experiences (Álvarez-Gayou, 2003). The goal is to access their viewpoint without making

quantifications. Additionally, we sought to obtain descriptions of specific situations and concrete elements of people's lives, rather than general opinions.

Before recording the interviews, participants were contextualized by explaining the purpose of the study and clarifying the use of the recorder when employed. The focus was on specific topics, although they were not strictly structured, allowing the interviewee to elaborate and ask unforeseen questions that proved useful for the study's objectives.

The interviews, with 24 individuals, were conducted through virtual meetings, telephone, and in person. The selection criterion for obtaining the sample was professionals who have work experience in mining and petroleum projects, belonging to the field of Earth sciences. The initial list was expanded through chain or network referral, by suggestions from other professionals. Those consulted reside in different parts of Argentina and some abroad. It should be noted that care was taken in the selection of the sample to include different age groups, with an aim to contrast the evolution of professional practices over time. Heterogeneity was also observed in the places where they worked; northwest Argentina[1], Patagonia (southern Argentina), Cuyo (western Argentina), and abroad: US, Spain, Brazil, Uruguay, and Colombia.

Only the authors were involved in the transcriptions, without the assistance of others. The memos prepared after the transcriptions facilitated the identification of analysis lines, synthesizing, at first glance, the elements of interest in each case (Borda et al., 2017). Subsequently, the themes derived from the analysis axes were coded. This task was developed as the coding progressed, relating the interview testimonies to conceptual categories. From this linkage, connections between themes and dimensions emerged, which allowed for the formulation of hypotheses based on the data.

As part of the interview protocol, participants were introduced to the conceptual framework of geoethics at the beginning of each conversation. This was done to ensure a common point of reference and to stimulate reflection on professional conduct and values. The explanation, based on Peppoloni et al. (2021), outlined four core aspects: (a) placing human beings at the center of all considerations; (b) the adoption of virtue ethics; (c) the necessity of deep geoscientific knowledge; and (d) the importance of spatial and temporal context. This framing served as a prompt for the semi-structured dialogue that followed.

[1] Northwest Argentine is composed of the provinces of Jujuy, Salta, Tucumán, Catamarca, and La Rioja.

3. Understanding the stages of mining: A foundation for geoethics and responsible resource management

The mining industry relies on an interdisciplinary network of professionals, each playing a crucial role in ensuring efficiency, safety, and environmental responsibility. Integrating geoethics into mining practices is essential for balancing the demands of resource extraction with environmental protection and social accountability.
Geoethics emphasizes ethical decision-making, accountability, and sustainability, guiding professionals to consider the long-term consequences of their actions.
In an era of increasing environmental awareness and community participation, understanding the mining lifecycle through a geoethical lens fosters a culture of responsibility and innovation. This approach ensures that natural resources are managed in a way that benefits present and future generations, preserving ecological integrity while supporting economic progress. Interdisciplinary collaboration is critical at every stage of the mining lifecycle.

3.1. Geoethics and the mining lifecycle

The mining industry is inherently interdisciplinary, requiring collaboration among geologists, engineers, environmental scientists, social specialists, and policymakers. Each contributes to responsible and efficient resource development. Embedding geoethical principles throughout the mining lifecycle promotes long-term sustainability and social legitimacy.
The mining industry is inherently interdisciplinary, requiring collaboration among geologists, engineers, environmental scientists, social specialists, and policymakers. Each plays a distinct role in ensuring responsible and efficient resource development. Beyond technical input, geoethical principles must guide professional interactions, decision-making processes, and stakeholder engagement. For example, geologists can inform community risk perception with transparent data; engineers can prioritize safer design solutions; environmental scientists can advocate for adaptive mitigation; and social specialists can ensure that local voices shape project outcomes. Embedding geoethics throughout this collaborative framework reinforces long-term sustainability and fosters social legitimacy.

3.2. Key stages of mining activity

A mining project typically unfolds in five main stages: prospection, exploration, construction, production, and closure. Each stage involves specific objectives, durations, and key professional roles (Table 1).
Community relations and engagement specialists play a critical role from the early stages of exploration onward. Their involvement ensures transparency, addresses local concerns, and supports long-term project legitimacy.

Stage	Duration (Years)	Description	Key Professionals
Prospection	1-5	Initial search for mineral deposits using remote sensing, geophysics, and preliminary sampling.	Geologists, Geophysicists, Remote Sensing Specialists.
Exploration	5-15	Detailed geological, geochemical, and drilling studies to assess the deposit's economic viability.	Geologists, Mining Engineers, Geochemists, Drilling Specialists.
Construction	2-5	Infrastructure development, including roads, processing plants, and mining facilities.	Civil Engineers, Mechanical Engineers, Electrical Engineers, Environmental Specialists.
Production	10-50+	Full-scale mining operations, extraction, processing, and waste management.	Mining Engineers, Metallurgists, Geotechnical Engineers, Environmental Specialists.
Closure	5-20+	Decommissioning operations, land rehabilitation, and community transition strategies.	Environmental Specialists, Reclamation Experts, Community Relations Specialists.

Table 1. *Stages of mining activity and their associated professions.*

Although mining is commonly described through stages such as prospection, exploration, and production, ethical and legal imperatives require including earlier stages, planning and permitting, where baseline environmental assessments, community engagement, and regulatory approvals take place. These stages are fundamental to ensuring the legitimacy and long-term sustainability of the project.

3.3. Transversal professionals (throughout all stages)

In addition to technical experts, mining projects require continuous involvement of professionals in law, economics, environmental management, and community engagement. These cross-cutting roles ensure compliance, dialogue with stakeholders, and integration of ethical standards.

3.4. The ethical imperative in resource management

Understanding each phase of mining is not only a technical necessity but an ethical one. Decisions made in early phases, like community consultation or environmental baselines, can define the social acceptability of a project. Geoethics urges professionals to consider not just "can we do this?", but "should we do this, and how?".

4. Exploration of the concept of geoethics

At the beginning of each interview, professionals were provided with an explanation of the areas of study related to geoethics, based on the framework proposed by Peppoloni et al. (2021): (a) the human being is at the center of all considerations; (b) geoethics is structured as a form of virtue ethics[2]; (c) it assumes a deep knowledge of geosciences; and (d) it considers space and time as contextual dimensions. This framework served as a shared conceptual reference to stimulate reflection and ensure a common starting point across participants from diverse backgrounds. However, we recognize that ethical professional behavior can take many different forms and is influenced by the prevailing cultural, social, and institutional values of each context. Our objective was not to evaluate alignment with a single fixed definition, but to explore how each participant's values and experiences intersect with key ideas associated with geoethics in the current international discourse.
While Peppoloni et al. (2021) define geoethics as a virtue-based ethics emphasizing personal responsibility and contextual awareness, this framework may fall short in providing concrete operational guidance. As some experts argue, there is a pressing need for explicit models of professional conduct, with standardized practices that can be applied across diverse settings. The current gap between academic training

[2] It is important to clarify that the notion of "virtue ethics" referenced here follows the geoethical framework proposed by Peppoloni et al. (2021), where it emphasizes personal responsibility, integrity, and reflective awareness in professional decision-making, rather than referring to the broader philosophical tradition of virtue ethics rooted in Aristotelian moral theory.

and the ethical demands of real-world scenarios is exacerbated by an industrial culture that seldom promotes systematic ethical reflection or training.

4.1. Limited conceptualization among professionals

Based on the fieldwork, it is generally observed that the professionals consulted do not demonstrate an explicit conceptual understanding of geoethics. However, there is a clear awareness of the need to frame professional practice within an ethical framework. While they may not articulate these ideas as part of a theoretical model, many appear to act in ways consistent with ethical principles, guided by personal values and professional norms rather than formal training in geoethical theory.
Some professionals explained the term geoethics by breaking it down etymologically, but without understanding the full extent of its application. Others stated that it is an idea "that is built as we go along." The lack of familiarity with the conceptual framework is a common denominator that identifies both those retired from the activity and those just starting their professional careers. Therefore, it was necessary to guide the reflection on personal work history through examples and hypothetical situations, explaining the areas of competence of geoethics and providing clear examples, in order to find in past or current experiences, circumstances where the concept can be identified and fully applies.
It is assumed that there are graduates who adhere to the ideal standards of the profession and who exercise a high degree of self-regulation through an internalized ethical code. This can be achieved through a strong process of professional socialization, where individuals internalize the values and norms of the field. When ethical behavior is driven by external controls, such as regulations or oversight, it may not be consistently followed. In contrast, when it aligns with personal values and becomes part of one's professional identity, it is more likely to be sustained. This is one of the core responsibilities of educational institutions. Through their curricular frameworks and graduate profiles, vocational training centers, institutes, and universities are tasked not only with scientific instruction but also with fostering ethical development. Ideally, ethical codes should be embedded naturally within the educational process, providing a foundation for future professional conduct.

4.2. Education and the missing ethical core

This curricular omission must also be understood within the broader evolution of modern societies. In previous generations, ethical values were often conveyed

implicitly through family, religious, or primary educational structures. As these sources of moral instruction have weakened or diversified, there has been a growing need to formalize ethical education in professional and academic settings. In this sense, the absence of explicit geoethical training in university programs may reflect a lag in adapting curricula to meet the ethical demands of an increasingly complex and pluralistic world, particularly in fields such as mining and geology, where decisions have profound environmental and social consequences.

4.3. The case for a curricular shift

The need to address geoethics in a systematic and transversal manner is raised by Lencina (2017), linking it to the level of undergraduate or tertiary education and closely related to Corporate Social Responsibility (CSR). The existence of these topics in the curricula is a starting point that must then be reinforced in professional associations and in the companies or organizations where professionals work; one geologist perceives it this way:

> *"For the concept of geoethics to resonate, it must start with university education. If professors don't consider it, students won't anchor it either. Geoethics is linked to other more widely promoted concepts like the Sustainable Development Goals (SDGs)g; in the end, they tell you, "Oh yes, I apply that." Marketing is important. In the European Union and the US, they talked endlessly about it, and now everyone knows what it is. The same thing happened with ESG[3] concepts; some don't even know if it's applied, but they care that ESG appears. If geoethics doesn't have a slogan, marketing, and if it doesn't appear frequently, it will continue to be lost out there."*

The Argentine Geological Association lists 18 Argentine universities where geology is taught. To corroborate or refute the absence of ethical themes in the curricula, the current curricula were accessed, with the exception of the University of Tierra del Fuego and the National University of San Luis. In none of the curricula were topics identified related to the ethical issues that graduates will face in their professional practice. Moreover, a traditional subject in any discipline, such as deontology, was also not found, demonstrating a significant gap in both design and academic discussion.

[3] Environmental, Social and Governance Criteria: https://corporatefinanceinstitute.com/resources/esg/esg-environmental-social-governance (accessed 18 July 20245).

Some curricula were developed very recently, a situation that makes the omission of geoethics content more surprising. As a counter-example, in the case of the Geology program at the National University of Río Negro, a significant consideration is formulated in the description of the graduate profile:

> *"Likewise, it is expected that the graduate will have an ethical attitude that allows them to act professionally, prioritizing quality of life, the cultural values of the community, and the preservation of natural resources and the environment."*

However, this is an exception within the context of all the universities in the country, but it is necessary that these contents be included under the label of geoethics, considering all the facets of this discipline.

5. The 1990's: A turning point

Those interviewed who began their professional careers in the 1960s and 1970s have experienced the turning point that represented working before and after the 1990s. This decade was a milestone in several aspects; on the one hand, it involved the entry of external capital exclusively for the mining sector and the incorporation of technology essential for the large-scale projects that began operations later. Those professionals linked to Earth sciences who were already in the labor market or were just starting their careers found in mining, especially in mineral exploration, an opportunity for professional development.

5.1. Economic opening and industry transformation

According to Sánchez Albavera (1999), until 1992, only four foreign companies were operating in Argentina; at the beginning of the 1990s, Argentina did not receive significant international corporate interest. However, its situation changed radically, accounting for 9.5% of the total exploration budgets allocated to South America in 1998.

Since the 1980's, and especially in the 1990s, the mining industry considerably increased its exploration budget, focusing on increasingly remote regions of the world (Ayeh and Bleicher, 2021). Unlike the 1980s, the net transfer of capital to the countries of South America became steadily positive. Investments were revitalized in almost all countries in the region. During the 1990's, most countries introduced

substantial changes to their mining legislation, adapting to the methods used in the extraction of low-grade minerals.[4]

Not only Argentina, but also Peru, Brazil, Guatemala, and Bolivia made these modifications, and toward the end of the decade, Colombia and Ecuador joined. All of these legislations considered the development of mining to be in the public interest, of public utility, or of social interest (Sánchez Albavera et al., 1999). Conversely, few mining legislations include a special section on investment incentives; Argentina and Peru are the exceptions. These two countries, along with Chile, offered the greatest incentives for mining investment.

5.2. New professional opportunities and ethical challenges

Interviewees' testimonies converge on the importance of this stage in the evolution of professional practices on several fronts: a) occupational safety, b) the beginning of considering environmental aspects, and c) the practice of the profession in a capital-intensive industry.

Those geologists who began their professional lives around 1960, while not always able to work in mining or petroleum due to limited demand, were not numerous. The existing institutions at that time for deploying their professional activity were the National Atomic Energy Commission (CNEA), Fiscal Coal Deposits (YCF), and Military Manufactures, and regarding the petroleum industry, in YPF[5]. There were few graduates, but also few opportunities, so some chose to develop or continue their training abroad through scholarships.

Those who entered the mining industry did so in deposits managed by mostly Australian or Canadian companies. With the experiences of other mines around the world, safe practices and continuous training were incorporated. One of the interviewee states:

> *"I started working for exploration companies in 1993 with the Mining Investment Law during the Menem era. The exploration boom occurred, and many exploration companies started entering. There was a shortage of manpower;*

[4] Technological advancements, such as heap leaching and bioleaching for refractory ores, have made it possible and profitable to exploit ores that were previously not economically viable, generating drastic changes in gold mining technique, and environmental impacts since the 1980s. These advancements, coupled with improvements in excavation technologies and the movement of large volumes of materials, have enabled the exploitation of surface deposits at lower costs than underground mines, whose higher costs are due to the demands of working in tunnels.

[5] Other sites involved in mining activities included the Aguilar mine in Jujuy, which extracted lead, silver, and zinc; the Ángela mine in Chubut; and the Gonzalito mine in Río Negro.

we, as professionals, couldn't keep up. Honestly, it was very easy to get a job in an exploration company."

Another testimony, however, reveals that this new scenario in the mining industry also had other consequences:

"The value scales of the new generations starting in the 90s were different, and a great deal of competitiveness arose among professionals that did not exist at the beginning. Perhaps the influx of capital into mining affected the deformation of professionals."

5.3. Before and after: A cultural shift in practice

Nevertheless, and despite the normal existence of differences in the appreciation of an event like the arrival of new mining efforts in Argentina, the testimonies recognize the beginning of a period that provided geologists and salt-flat mining engineers with technical training and respect for good practices, particularly when compared retrospectively:

"Throughout my career in companies, there has always been a strong emphasis on environmental and social issues. These matters were always carefully considered. I believe that mining, especially since 1993, has had a very different imprint compared to the 1960s and 1970s.
I know from what I've heard that in Patagonia, particularly in XXX… if people needed to access an area and there was a fence in the way, they would simply hook up a truck to it and tear it down. They wouldn't bother to look for the landowner, ask for permission, or even talk to them. No, no, no. If they needed to reach the vein of ore, they would do whatever it took, without any regard for anything else. That's why people there have such resistance to the history of mining abuses, which has since changed. I can tell you that, in terms of safety, the company really pushed us to wear seatbelts until it became a habit, because here in San Juan, no one ever used them before. They hammered us about it every day – protective gear, goggles, gloves, helmets, vests, boots – until it became routine."

5.4. Learning from Experience: A Personal Evolution

Up to this point, the testimonies reveal that concerns about environmental protection and company – community relations have been consistently present, both prior to and following the 1990s. For a long time, it was widely assumed that obtaining written approval from political authorities was enough to legitimize project activities. Overcoming this perception has required years of awareness-building and has been shaped by repeated episodes of social conflict. As one interviewee stated:

> *"I always believed that all mining rights outlined in the mining code, etc., granted absolute rights. Just as I initially believed that I also thought… the inhabitants should adapt. For example, in the salt flats, the communities of the high plateau, I was hit with a brick when I realized that we were wrong."*

There is a consensus among the testimonies regarding the limited weight that a permit to explore can have. In certain places, it is a necessary requirement, but not sufficient. The practice of enforcing an official permit to explore private land or land belonging to indigenous communities became an obsolete practice if it was not accompanied by a personal approach from the geologist, acting as an ambassador for the company or a specific institution. As a volcanologist geologist states in his experience as a researcher in other latitudes:

> *"In the 80s, you could go anywhere and do whatever you wanted. Then the requirements of having licenses and permits started to control the use and abuse of resources… You always had to ask for permission, but that didn't mean anything. It was just to show the permit to some police officer. When I came here, I learned to get by without legal permits or documents. It was about talking to people, starting with a home, which is a house with eight sides and earth on top (a Navajo hogan), with the door facing east. I had to start with a family, and they would say yes or no, and in turn introduce me to others. Once I had met enough people, I could start working. Everything was about personal contact. And yes, I had to have that permit, but it was worthless."*

The U.S. Bureau of Land Management[6] advises that, regarding permits, you should obtain authorization to access the land where you will be working, either from a landowner or an agency. When requesting permission, present yourself accurately, providing information about your credentials, as well as any institutional

[6] https://www.blm.gov/ (accessed 21 July 2025).

or company affiliations, what you intend to do, and what you will do with the data and samples collected. This is what should be done beforehand. The next step, with the data collected, is to inform the landowners about your findings, if any, since they have an interest in their land. This government agency recommends sharing the results of what was found in the field. Working with private landowners is a partnership, so it is ideal to share a copy of the research results (resulting article, summary, or professional presentation) with the landowner, even if it is years later. These recommendations are valid not only for geological fieldwork in the U.S., but, being common sense criteria, they are universally applicable. The same interviewee, when speaking about his work in Yellowstone National Park[7].

> *"My experience isn't in mining, it's different. I'm a volcanologist. There are aspects of geoethics in that too. We study volcanoes and volcanic processes, but we have to communicate the data and start building relationships with the community before a crisis. We also have to learn their ideas, from the locals. Sometimes it's the indigenous people who have their own way of seeing the volcano, and it's important to know how to communicate when there isn't a crisis, so that when there is one, we're prepared. When we're exploring the volcano, people want to know things. They want to know if we're looking for any resources. I've received permission to work on a piece of land, and the landowner has said, 'If you find anything of value, let me know because I'm interested.' That causes conflict because they expect me to make commitments, and I'm not supposed to. I always just keep quiet."*

A geologist who has spent his entire career in Argentina, primarily in Patagonia, cites a similar experience regarding the communication of results and the interest of landowners:

> *"In 2003, a junior mining company conducting exploration in Patagonia had four teams of geologists. The Chubut region was sensitive, and there was a ranch where the owner was usually absent as he lived in Esquel. We informed him about the exploration work, which was harmless, and I was able to reach an agreement with him. He asked me, 'If you find an interesting rock, could you bring it to me?' And I happened to find a very nice granite. I discovered an anomaly that seemed interesting, took some samples, and sent them to the laboratory. Meanwhile, the samples were analyzed and found to contain gold. When an English colleague and my Australian manager saw the results, they took a truck on a Sunday and*

[7] Yellowstone National Park is located in three states: Montana, Idaho, and Wyoming, USA.

entered the property through the gate next to the house without stopping. When they returned, they found the gate locked with a padlock: we could never enter again. These were instances where the basic rules of coexistence were broken, and tensions were already high in Chubut (Argentina),"

One recurring observation is the state in which the mining sites were left regarding mining waste, described as a 'fait accompli': '*Before, nobody took care of the tailings*.' A paradigmatic case that confirms this assertion was the Gonzalito Mine in the province of Río Negro, which extracted bentonite and processed the minerals in San Antonio Oeste.

Those who have had the opportunity to observe the state of the mine and surrounding areas attest that it is an undeniable case of malpractice regarding mine closure, or better yet, a total absence of remediation measures, as it did not adhere to any best practices:

"Here at the Gonzalito mine in Río Negro (Argentina), they left all the tailings, some at the port (San Antonio Oeste) and some at the mine itself. It was abandoned, and we took it over to do some exploration. I was tearing my hair out thinking, 'Here we have an environmental liability that we'll need to document now, and we're going to have to rectify it if we move forward with the project."

The same interviewee provides other examples where the disregard for environmental and social consequences was evident:

"Everyone who takes the Tren a las Nubes (in Salta, Argentina) and crosses that beautiful bridge will see that it's full of mining tailings below. I saw what happened in Mendoza with Sierra Pintada. The National Atomic Energy Commission (CONEA)[8] *wanted to reopen it, but the companies had abandoned the mine when the uranium price dropped, turned off the lights and left. They left 200-liter drums with who knows what, saying 'go ahead and clean it up!' But the same anti-mining activists wouldn't allow it to be done. It's a manageable mine, we could be extracting uranium and exporting it today."*

Undertaking professional activities without incorporating ethical considerations may initially appear advantageous; however, it often leads to challenges related to value-based decision-making, such as establishing priorities or choosing appropriate criteria. These challenges underscore the need for consensus on the values that

[8] https://www.argentina.gob.ar/cnea (accessed 31 July 2025).

should guide such decisions. As Cortina (1996) argues, for any activity to attain social legitimacy, it must not only fulfill its intended productive goals but also uphold the rights recognized by society and align with its prevailing value system. There is an unavoidable interplay between the normative principles inherent to a given professional field and the broader ethical expectations of civil society. Disregarding either dimension can ultimately undermine the legitimacy of the activity itself.
That validation has been lost in some places, almost irreversibly, thanks to examples of malpractice, and allowed for the emergence of credible spokespersons. These are residents or organizations made up of people whose way of life is affected by mining or the oil industry, or any professional practice linked to Earth sciences. These actors, previously passive, know that they cannot be excluded a priori from the discussion, simply because they are the ones who later face the consequences when there is no agreement on ethical standards. Scott Foss, an American paleontologist, recalls (Foss, 2019):

> *"I used to work in a national park, and I remember how the staff would complain when we heard that a university geology field camp was setting up at the campground. Most came and went without incident, but enough problems occurred that the park employees developed a negative perception of geologists. Training future geoscientists in the field is a hallmark of professions related to geosciences, but we need to do a better job teaching the ethics of field work."*

6. Security and safety

Mining has always been, and continues to be, a hazardous occupation. The activities we describe here are completely different from artisanal mining practices. Standards for workplace safety began to be taken seriously in the late 1980s, as exemplified by the Farallón Negro Mine (Catamarca) and the Aguilar Mine (Jujuy). At that time, safe work practices were not yet internalized into workers but were enforced strictly. With the arrival of large-scale projects, strict safety protocols, daily safety talks, and supervision of compliance were also incorporated. Environmental considerations are a variable that is landing with increasingly explicit guidelines in projects. A senior geologist points out:

> *"In the 1980s, safety measures were gradually imposed and became mandatory in the following decade. Then, in the 1990s, environmental issues were incorporated, and in the 2000s, community-related issues linked to projects gained greater relevance."*

In all projects, several minutes are used daily at the beginning of the workday to internalize safety topics, as stated by a professional who started working in mining in the early 2000s:

> *"People assimilate it, first through effort. We have 5-minute talks, well... what are our principles? When the project is active, the 5-minute talk is done every day. Safety talks too, you mix everything. It starts with safety, then we continue with an open topic, and generally, we do warm-up calisthenics, mainly for integration purposes. The safety talk is a requirement, and we look for new topics, we look for things that happened, we talk about underground mining. Even if we're in the exploration phase, it's done daily."*

As previously mentioned, Peppoloni and Di Capua (2021) delineate four areas where the characteristics of geoethics are: (a) centered on the human agent, (b) configured as virtue ethics, (c) based on knowledge of the geosciences, and (d) with approaches dependent on the spatiotemporal context.

Placing the human agent at the center refers not only to those who are affected by scientific or industrial activities, but also to those who carry them out. In this regard, upholding occupational safety standards, particularly in work that entails inherent risks, constitutes an essential expression of the first domain of geoethical responsibility.

In the hydrocarbon industry, negligence regarding safety issues can also lead to a disaster that results in the deaths of operators and professionals. However, it is the latter who, in practice, act as guardians of the company's safety protocols. The group of interviewed Earth science professionals working in oil and gas began their careers in the early 2000s and have a perspective that goes beyond merely respecting safety regulations in a legalistic manner; they have a consciousness of the real danger of carelessness or negligence. Here, as in mining, the role of the union is important in protecting workers, primarily the operators. Testimonies from the oil industry reveal a cultural gap in the field between young professionals and those who have already completed a large part of their careers and have a lot of experience, but also an often-anachronistic perspective on practices, which is summed up in the phrase "*it's always been done this way and nothing has happened.*"

If a disaster were to occur, the engineer or geologist in charge of the location would have to account for conduct that is not supported by company regulations and could be fired. This petroleum engineer expresses his experience as follows:

> *"I remember we were leaving for another location, and the next day one of those Well Testing guys went to hit a line, and it exploded in his face. It was 2000 psi...*

imagine that car tires have 30 psi, and if it explodes in your face, it does a lot of damage. That's when they unified a bit more, how we assemble the lines and what kind of safety they have to have. It happened to Production, but they start working while we're disassembling, they come and ask us, "Hey, can we do this?" In the company, they say our standards were written in blood."

7. Mining: The emblematic BreX case or the antithesis of geoethics

BreX Minerals Ltd. was a Canadian mining company founded in 1988. It focused on gold exploration and extraction. In the early 1990's, it acquired a property in Indonesia that was presumed to contain a large gold deposit. In 1996, BreX announced that this large deposit had been discovered, which triggered a massive increase in the company's share price and raised the company's value to more than US$6 billion. However, in 1997 it was revealed that the gold deposits were a fraud, causing the price of BreX shares to plummet.

The consequences were varied: investors suffered capital losses, the company founders faced criminal charges, and the entire world of mineral exploration became subject to suspicion. This embezzlement triggered the implementation of robust regulations. Thus, the National Instrument (NI) 43-101 was created, which sets standards for the disclosure of information on mining projects in Canada, similar to the JORC Code in Australia[9].

NI 43-101 requires that information on mineral properties be prepared or supervised by a "qualified person" and defines the requirements for the content and format of technical reports. The objective of NI 43-101 is to protect investors from misleading information about mining projects, requiring scientific and professional information. Those interviewed who spontaneously mention this milestone belong to the same age group, and clearly remember the effects of these changes, sometimes from a first-person perspective.

"... in 1998 there was a very large instability in the mining sector due to the gigantic fraud that occurred in Indonesia, BreX. Mining stocks fell, and then I decided to look for another path and applied for a CONICET scholarship. The small companies we worked for went bankrupt and started laying off all the geologists. The shares plummeted, and it became an investment area with

[9] The JORC Code, developed by the Joint Ore Reserves Committee (JORC) of Australia and Asia, was established in 1971 for the presentation of reports on exploration results, mineral resources, and ore reserves.

zero credibility, so investors withdrew their shares, their funds, and put them into other things, like fertilizers, cotton, petroleum, anything but mining."

Other testimonies consider that it was the beginning of more controls, rules, and audits and determined a period of greater administrative transparency. Regarding geological information, this transparency gradually expanded toward the relationship with communities and the government. Among the professionals interviewed, there is the idea that changes in mining activity occur as new events arise and, as a consequence, the industry tries to adapt. The BreX case represents this reactive dynamic.

8. The junior company context: High risk, low structure

Most of the geoscientists interviewed worked in mineral exploration, known in the mining industry as juniors, and some of their career paths changed towards production or towards managerial positions in large companies. Junior companies constitute the smallest units within multinational corporations and focus primarily on exploration, although, in some cases, they also participate in extractive activities. The term "junior companies" is closely linked to the world of financial markets and investments, where it is used to classify all small mining companies that are more vulnerable to fluctuations in mineral prices and are, therefore, the most volatile and high-risk part of the sector. Consequently, they depend on and are at the service of a financial public interested in investing in companies with little capital, a short history, but with high expectations of obtaining large profits. The Toronto Stock Exchange (TSXV) and the Alternative Investment Market (AIM) in London are specialized exchanges that connect these investors with emerging companies seeking financing for their operations. Junior companies focus on their core business, geosciences, but given their limited resources, they are generally pressured to obtain quick financial returns and often present as a weak flank, the performance in social and environmental aspects. These companies bring together geoscientific knowledge in areas such as geology, geophysics, mineralogy or modeling, but their small teams generally lack the experience, infrastructure, and necessary equipment to carry out responsible mining. In general, community relations are not a carefully managed corporate aspect; its implementation is in the hands of professionals, but in a rather haphazard way.

8.1. Professional autonomy and ethical judgment in the field

Boon (2020) points out that, while these companies may not have a solid structure with a specific area responsible for community relations, they can still do it well. In the advanced exploration stage, drilling is more extensive, more equipment is involved in moving earth, and up to 50 employees could be working in the field. These actions will inevitably arouse the curiosity of the local population, which is why, during advanced exploration, greater attention should be given to the social aspect. The geologists interviewed are aware of their responsibility, both towards the physical environment and towards the local inhabitants. Geologists who are now in their 60s were the figureheads of the exploration company in the field and had to resolve unforeseen situations, not only those of a technical nature but also at a human level. Among the latter, the mandatory step is to ask permission to enter a property. There are numerous anecdotes of both good and bad practices, mainly on the ranches of Patagonia.

> *"You might be pressured by the company, but you also know that if you make a mistake, the entire project can be halted. It's one thing to feel pressured, and another thing entirely to act like a professional and understand that because of your error, the whole project could be stopped. Sometimes the technical aspect became completely secondary, and even more so. Progress and connection were much more important... that's why I did well and ended up going to advance the projects myself. Once you do that work, the relationship becomes smoother and flows faster, but you have to invest time.*
> *It's about going to talk, you grab your truck, you chat with the people, and you tell them you're going to pass through there. Sometimes when the person is very receptive, they might think that their whole life is going to change, and the truth is that that can't be the case. Besides, the benefit can be very unequal because, to give you an example, the road trace passes through one of the properties and not through the others, so you're paying one and not the other. When you use horses, for example, you have to be quite equitable so that there are no dilemmas, because they are neighbors. You have to handle it well, if you use one person's horses, you have to hire the other's son for something else, spend money on one and do it on another."*

It is not solely a matter of adhering to the established principles of relationships; at times, it is also necessary to moderate the overly optimistic expectations of certain owners who presume that exploration will inevitably lead to a profitable discovery. Furthermore, the various stages of the process are not always managed

by the same junior company; one entity may be responsible for the prospecting phase, while another may handle the initial exploration, and so forth.
Investment is not only about capital, but also about the time spent listening to concerns, observing and explaining technical issues, especially in difficult cases, without any guarantee of success:

> *"It has to do with the stages. If you've moved on to exploration, it means you've already spent five years. By that time, access routes have been established, permits have been obtained, and the exploration company might not even be the same as the one that conducted the prospecting. They probably hire new personnel to manage community relations. That work is very personal; if you need to take a flight just for a half-hour meeting, you do it. I've gone and returned with no results, only to go back again. You have to build trust gradually – it's an investment."*
> *"The official authorization you carry might not be enough. I once had a situation with a rancher in Santa Cruz who didn't want anything to do with the project. He had mistaken me for someone from the previous company who had cut through his fences without consent. So we sat down, and instead of talking about the project, we spent two hours discussing that broken fence – and the fact that no one had ever compensated him."*

Some professionals in our field have not only worked in mineral exploration but have also had the opportunity to work in production or exploration for larger companies. In certain cases, the notion of the exploration geologist as a seeker of valuable mineral deposits is grounded in real-world practice. These are cases where the professional has the freedom to decide and where their own values about how to relate, and other issues that may create doubts about how to proceed, come into play. The budget is not abundant, but there are degrees of freedom for professionals, which vary according to the company. A geologist who has always worked in exploration until becoming a manager of the area, states:

> *"I continue to try to see the geologist not as an enclave, alone in the middle of the field, or doing what the company tells them to do. I believe we are people, and we have within us the mark of social beings and ethics and respect have nothing to do with the company or the profession, it's something inherent to humanity."*

8.2. Learning by doing: Ethics without a manual

Although the testimonies presented in this section refer to everyday professional situations, they illustrate how ethical learning often takes place informally, through personal experience, peer interactions, and real-time decision-making. This "learning by doing" dynamic highlights the lack of formal ethical instruction, which compels professionals to construct their own moral frameworks through trial, error, and adaptation within complex operational settings.

In another section, we explore how values emerge strongly in participants' narratives, particularly during challenging moments in their careers. Some interviewees noted that large mining companies tend to "set the bar high" in terms of social responsibility, often due to stricter adherence to regulatory frameworks. Professionals working in companies with both exploration and production divisions reported gaining a broader range of experiences, which allowed them to navigate different responsibilities and expectations. However, such opportunities are more common in mid-tier or large companies and not typically found in junior firms. For instance, Minera Alumbrera in Catamarca once made the strategic decision to shift its capital expenditures (CAPEX[10]) from exploration to production. Interviewees who experienced both roles emphasized that the responsibilities and degrees of autonomy differ significantly between exploration and production. Interestingly, two participants remarked that they only truly identified as "geologists" when they were engaged in exploration work.

Case A:

> *"I worked in exploration and had a brief stint in production, but I wouldn't count it because I didn't like it. Production is a very stressful job; it's a chain of responsibilities where you receive a deliverable and continue it; and if what's handed to you is a mineral, a shift, or whatever, you're responsible for any errors it brings. Additionally, in production, you work 24 hours a day, whereas in exploration, you manage your own time. Exploration depends on the weather and daylight. The production process is like a factory, the closest thing to it. Exploration has a bit of romance, although it also follows medium-term steps. The day-to-day is more demanding in production."*

[10] Capital expenditure.

Case B:

> *"By then, I had already been working in production for a while, which is a very stressful function. That's just how it is in production; you have to interact with financiers, the commercial department, and so on. Even if you're not prepared for those subjects. On the other hand, exploration is 100% geology. I chose geology because I was a rock climber, and exploration also requires a lot of science. You don't find mines every day."*

While geologists are generally associated with field work, there are notable cases of professionals who, after beginning their careers by exploring large deposits, spent nearly their entire working lives at a single site. Over time, they transitioned through various roles, not only in field-based exploration but also in planning, project development, and even managerial functions. This continuity allowed them to develop a profound understanding of both the geological characteristics and the operational dynamics of the project.

> *"In 1994, I continued working in exploration, production, mining control, environmental management, mine closure, sustainable development, and community relations until 2018."*

One recurring theme in the interviews is the role of professionals within hierarchical structures, particularly when assuming managerial responsibilities. As responsibilities increase, they often face ethical dilemmas that require either taking direct action or escalating the issue to higher levels of authority. Escalation may be necessary when the professional lacks decision-making power, when legal or reputational risks are involved, or when the issue conflicts with broader organizational interests. In such cases, ethical behavior involves not only following established regulations but also navigating company protocols and internal hierarchies responsibly.

> *"Decisions were made collectively by us and the area managers; the chairman had no input. We were managers there, meaning we were not geologists, but rather managers. There is a clear role change. When you transition to management, you need to be prepared. Personally, I was prepared at Minera Aguilar, with a psychologist providing us with an annual course. Minera Aguilar had very interesting initiatives at the time*[11]*."*

[11] Minera Aguilar was described by several interviewees as a training ground for professionals, not in a formal sense, but through comprehensive, on-the-job learning integrated into daily work.

It is a common occurrence for an exploration team geologist to eventually ascend to a managerial position. This also presents a challenge for maintaining healthy interpersonal relationships within the work group.

> *"Some believe they can manage solely through empathy, as they will have a responsibility. However, being 'Mr. Empathy' is not effective either."*

This is particularly true in technical fields such as geology, where professionals are often trained as individual contributors and may lack the interpersonal or managerial skills needed for leadership roles. Promoting a talented scientist or exploration geologist to a managerial position without adequate training can result in poor leadership, as technical expertise does not automatically translate into management competence.
Nevertheless, if the exploration manager was previously a member of the work team, the challenge will be to exercise leadership in the same context, and here non-technical skills undoubtedly become relevant.

9. Fieldwork and the perspective of distance

One of the key themes that emerged from the interviews is the differing perspectives between professionals working in the field and executives based at the company's headquarters. At times, discrepancies arise, leading to conflicts between these two viewpoints. This issue was highlighted by interviewees working in both the oil and mining industries; however, in the hydrocarbons sector, the timeframes for action and decision-making are significantly more constrained.
In contrast to decades ago, every mining and oil company has protocols, good practice manuals, and considerations that did not exist before. However, situations frequently arise in which the geologist's or drilling engineer's judgment does not align with that of the area executive, and in these circumstances, the variable of distance or being at the well, and in the reservoir, radically alters the perspective.
This dichotomy of action criteria is not permanent but arises on some occasions and intersects with other nuances. For example, there is not always a vertical hierarchical structure, but rather areas of responsibility in decisions tend to overlap, as they express:

> *"I've worked for both American and Argentine multinational companies that have policies about what not to do… they were written by someone from corporate headquarters in the US, and we're working in Santa Cruz, 15,000 km away; and*

the guy who's here in charge of the operation is also being asked for numbers, results, and profits. Yes, it's fine, there's the corporate policy, however, corporate headquarters asks me to follow the policy, but the guy on the left asks me for money, so who do I listen to? And they're at the same level or the one who asks me for money is even higher up."

The advancement of communication media, satellite telephony, and fiber optics has diminished these problems, but they still persist when high-level decisions are involved, and when there is a chain of commands that cannot be ignored. The person who is faced with the dilemma of how to act is part of the company's structure and must resolve it solely with their moral conscience:

"But what is the company? The professionals who compose it, so there the company may have super strong ethical policies at the board level, but they have a general manager who is a crook, and the board doesn't know. Because the board is in New York and the manager is in Ecuador. And who dares to report the general manager to the board? That's where the company's codes of ethics and conduct are supposed to work."

Some actors within companies do not directly suffer from the contradictory versions, but they can observe the inconsistencies between the letter of the law and the criteria to be applied in the field. These situations are more frequent in the oil industry where every minute of delay matters and has a high cost. Thus, an environmental professional responsible describes the occasional dilemmas that geologists face in the field when making decisions:

"That's exactly right, because they're the ones who do the work, and they're the ones who call you and say, ¨They're asking me to move forward anyway, help me justify why they're asking me for results and you, on the other hand, are asking me for this, help me show it.' In a way, you have to do some lobbying, and they ask you for field support to lobby here in Buenos Aires to say: hey, give us a clear directive from Buenos Aires so that they don't do this here."

Or, also in hydrocarbons:

"It happened to us with the Chinese company: 'Yes, no... because the environment is really important,' but then the guy left the meeting and called the field operation, to say 'everything I just said is bullshit, don't pay attention to it, move forward.'

Then the guys in the field would come to you for help, and they explained to me that they would receive calls behind their backs afterwards."

The arrival of regulations related to safety, the environment, legal matters, and community relations has not yet permeated all levels of companies. It is true that finding the right balance between achieving a certain level of profitability and strictly complying with regulations can be very difficult, but if care is always postponed in favor of productivity – which is nothing more than profitability – protocols can become nothing more than a superficial image makeover for the industry, or a hypocritical and merely formal instrument with no anchor in reality. Lipovetsky (1992) describes this practice as the misery of ethics, which when reduced to itself, resembles more superficial makeup than an effective tool to correct the vices or excesses of our individualistic and techno-scientific world.

There is a brake that can sometimes be applied, instead of simple awareness, and that is to appeal to the legal consequences for skipping a rule. This inevitably happens when a disaster occurs, for example, a cyanide spill in mining. This tool often has to be invoked to enforce internal regulations:

"We have to try to raise awareness… sometimes they don't care about what should be done, and sometimes we have to try to play by telling them the consequences that this can bring, not only for the company but for you as a decision-maker. Not to scare them, but to inform them. There are important issues that can damage the company's image, and there are also issues that can have criminal consequences for them. So, not only can they cause losses to the company or damage its image, something that can be irreversible, but you as a person can also pay for it."

Many times, the legal department in companies is responsible for raising awareness about the consequences of a reckless or non-compliant action, or simply a hasty action taken to respond to pressure:

"The legal team that advises us was telling us the other day to be careful because the justice system is targeting higher-ups now. It's no longer just the technician who didn't do what they were supposed to do, but the company's CEO or vice president who says, 'Look, I can't be everywhere because there's company policy and that guy didn't follow it.' But they call you behind the scenes and tell you not to pay attention to corporate policy, it doesn't matter. But then something happens in the field, and the one who gets exposed is the one who messed up. Today they say that the people at the top can't claim ignorance

of what's happening, and if they don't know, it's because they were negligent, for not having been monitoring, so they face the music too. That's changing, and we need to make people aware of it. If you don't do it out of conscience, do it because of the consequences."

Differences of opinion can arise at different levels. A former safety manager from a mine with a long history in northern Argentina recounts:

"There were protocols from the parent company that required theoretical and practical training, psychometric evaluations, and more. We were falling behind, unable to fully certify workers in areas like rock support, heavy equipment operation, blocking systems, and working at heights – there were ten protocols in total. At one point, I had enough: I halted operations for two days. First, we gathered 100 to 150 workers in our on-site microcinema to conduct the training sessions. Then, we went as a group to the hospital to complete the psychometric evaluations. Management wasn't happy because no ore was extracted during that time, but I didn't want to risk further problems. A manager is like a fuse – they're the first to take the heat when union issues arise."

10. Role of regulations in protecting professional performance

Regulations can be of different kinds: in Argentina, some come from the governmental units controlling the mineral resource, with the provincial ones being most important; others are related to bureaucratic aspects, and still others to ensuring the provision of water to the area of influence, as an example.

Other procedures are specific to extractive industries, such as GRI[12], or exclusively for mining like HMS (Hacia una minería sustentable – TSM in English), which was initially designed for Canadian mining companies and in Argentina is the responsibility of the Argentine Chamber of Mining Companies (CAEM)[13].

Finally, corporate principles vary from company to company. Given that the mining and oil industries need to present themselves as ethical actors, they have incorporated terms such as Responsible Mining, which includes CSR (Corporate Social Responsibility), or more recently Shared Value, an evolution of the former.

[12] https://www.globalreporting.org/ (accessed 21 July 2025).
[13] https://caem.com.ar/ (accessed 21 July 2025).

These definitions, regardless of their historical development, lack universal consensus and tend to reflect a corporate narrative about the business. This narrative often produces internally regulated frameworks that align with politically correct standards. However, these frameworks may overlap or remain largely theoretical, with limited practical implementation.

Due to increasing public demand for responsible behavior from mining and oil companies, international credit institutions such as the World Bank have promoted ESG (Environmental, Social, and Governance)[14] frameworks to integrate multiple dimensions of project accountability. While regulations, regardless of their origin, cannot guarantee ethical conduct or best practices, they do provide a framework within which geoscientists can act responsibly. It is important to distinguish between governance and ethics: governance refers to institutional mechanisms and rule enforcement, while ethics concerns the values and principles that guide individual and collective behavior. Nonetheless, poor governance can often reflect underlying deficiencies in ethical commitment among those responsible for implementing such frameworks. In regard to the oil industry, an interviewee in the environmental industry says:

> *"Specifically, (the company) has a significant social impact because the company owners are very socially conscious and pay a lot of attention to the communities where they operate. They have countless community development programs and initiatives with contractors. This is very noticeable… The Americans also had a fairly significant social responsibility program, I don't know if it was out of conviction or for image purposes, but the Chinese cut everything. And now it's been revived. This whole issue of sustainability, which has an environmental, social, and governance component, has the most development in the social area; so, we are trying to align both governance and sustainability to create a more balanced block."*

It is worth noting that in this statement, the interviewee uses the term "social impact" to describe the company's voluntary efforts in community engagement and development. From a geoethical and socio-environmental perspective, however, social impact refers to the actual consequences, both positive and negative, of a project on the surrounding communities, regardless of the company's intentions or efforts. Corporate initiatives are better understood as mechanisms for managing or mitigating such impacts.

[14] For more information on ESG: https://esg-central.com/ (accessed 21 July 2025).

As a corollary of this approach, it can be inferred that social conflicts are minimized:

> *"… to the point that we have not had any significant*[15] *conflicts, except for superficial ones. However, these are more of a commercial issue, as the surface owner fights for what happens within their property."*

It is evident that an abundance of procedures, if they are excessive and not well integrated at all levels of the company, can lead to them being ignored in certain circumstances. In the oil and gas industry, this problem has been repeatedly mentioned in interviews, unlike what happens in testimonies related to mining.

> *"Today, there's a concept called operational discipline. In a nutshell, it means doing something once but doing it right. And doing it right means doing it safely, with care for the environment, for people, and for the company's economic assets. The reality is that the company is very large, there are thousands of people, and everyone takes their own actions. There are places where operational discipline is followed and others where it's not… If everything they say were true, it would be wonderful, it would be an ideal world. This is the procedure for how to drill, and if everyone followed it to the letter, it would be ideal. Even so, I've seen how sometimes (in other places) people turn a blind eye and we lose that follow-through, which would be ideal if we complied with it. Fortunately, I don't have a company that tells me: do it now, no matter what. No, if the guideline is here, why would I do it differently?"*

The existence of extensive regulations is only a framework. That is, it can be decorative, politically correct, or just 'empty talk,' according to one interviewee. Alternatively, it can be a framework that contains and limits the constant drive for productivity to which the gas industry is subject, for example. This is where the internalization of what is right by each professional can make all the difference:

> *"I believe it no longer depends so much on the structure or the idea the company has, but on each of the individuals working there, and whether those principles are going to be a tool on how to continue or… many come and seek quick results, they have to be fast. For me, we shouldn't seek a result but rather act in a certain way that consequently… that (the result) has to be a consequence of how the actions are."*

[15] The term "significant" reflects the interviewee's subjective assessment. In academic or policy contexts, social significance is usually determined by criteria such as scale, duration, and affected population.

The same interviewee offers a technical example that illustrates the aforementioned:

> *"For instance, in hydraulic fracturing, where two fracturing stages are done per day on average, my boss loved to say 'let's go for 3, let's go for 4' because it's measured by time. Talking about 3 or 4 means working faster at high pressures, with rushed people who don't notice if they have a valve open or not… so instead of saying 'guys, let's go for 4 stages today,' we should say, 'today at 9 am we'll start one, and we'll start and finish it.' Speed should be the result of many good actions, a consequence. I have a colleague who tells me, "You are very Disney… you believe in the idyllic.' But I follow the tools they give me, these guidelines, and it depends on who reads them, they can say this is a lie or they can take them. I take them, and that protects me."*

Those geoscience professionals who work in hydrocarbons, particularly those in the upstream sector, are subject to constant pressure from two mutually identified variables: time and cost. The upstream stage encompasses reservoir, production, drilling, and well completion, and is where most of the investment is applied. The task also includes taking care of the environment, health, and safety in the field, ensuring the integrity of the well, and protecting the company's assets. Additionally, the questions that must be answered are linked to the pace of work at the well, which are related to maximizing performance in the two key variables, time and cost. The questions can range from: 'Why did this happen?', 'Why did you take half an hour here?', or 'Why did team 1 take 15 minutes?', or 'Why did you spend so much on this?'

11. Distinctive attributes of geologists and engineers

Geologists and experts in various engineering specializations were interviewed; some are exclusively related to mining, others to oil, and one is an industrial engineer who is working in an oil company.

In the mineral exploration stage, geologists take center stage. The exploration stage of a mining project consists of several phases that require different technological procedures and specialized personnel, but it is fundamentally about geologists. The evaluation to determine if exploration is viable is normally based on a preliminary review of all publicly available geological information, followed by airborne geophysics, sampling, analysis of surface soils and rocks, or geological mapping. These tasks primarily involve geoscientists such as geologists, geophysicists, geochemists, mineralogists, among others.

Mining engineers become more involved in the pre-feasibility, feasibility, detailed engineering, and construction phases of a project once the exploitable resources have been defined.
In line with mining, an interviewee, a mining engineer, highlights the different fields of both professions:

> *"A geologist has a much broader scope of work. They can dedicate themselves to mineral prospecting, exploration, and production. Additionally, they can delve into research areas such as sedimentology, ore deposits, and economic geology. The mining engineer, on the other hand, has a more limited focus, typically working in a mine, a concentration plant, or in production planning. Their areas of expertise overlap with geologists in fields like geomechanics, a specialty that has grown significantly in recent times due to the primary hazard in underground mining, which is rockfalls."*

Through these dialogues, recurring themes have emerged. One spontaneous theme is the contrast between geologists and engineers. Engineers are associated with production, performance, and the efficiency of a process, and the use of indexes, etc. In contrast, geologists are perceived as being closer to a scientific and integrated perspective, as evidenced by the consequences:

> *"I believe geologists are indispensable in a mining project, and they have that romantic bias. If CEOs and executives could do without geologists and hire all engineers, they would, because they would question everything much less..."*

There are studies that document the dichotomous approaches between these disciplines in practice, as well as ethics in engineering (Herkert, 2005; Sorkhabi, 2016; Cech et al., 2017; Smith, 2019) that corroborate emerging attitudes from fieldwork with interviewees. In particular, the supposed dichotomy is observed more clearly in the oil and gas industry, given that the exploration-exploitation stages involve collaborative work at the well site. Not only is that, but the pace of work much more demanding than in mining.
A drilling engineer, who operates in tight gas wells, alludes to cost, one of the variables that condition rapid and efficient performance:

> *"In drilling, it can be US$60,000 to US$70,000 per day. Imagine that an oil well today, a non-conventional well like tight gas (which they call conventional, to say that we have something conventional), the drilling alone is US$3.5 million. Then come the hydraulic fractures, which are another US$3.5 million, that is,*

it's US$7 million for just one well to be put into production, and these would be just the operating costs. There are other costs that I don't see clearly since the location is made and others…"

The perspective of a geologist who has been working in gas production for about 4 years, as a reservoir engineer, refers to the two conflicting perspectives:

"… But the engineer who designs, they got mad at me once, they measure (in terms of productivity) by drilling speed, while they measure us by the volume of gas produced. They want to make holes fast, but we can produce less gas if they don't do it well. If you go fast, the well starts to take an angle and becomes vertical, the consequence is that we produce less, because we compact more vertical sand than if it's crossed. What is my job? To make them understand… that part they don't see, and that's where the concept of geoethics comes in, I don't know if it's something that can be taught."

There is an underlying demand for geoethical parameters that integrate both approaches. Ayer and Bleicher (2021) point out, with respect to geologists and mining engineers, that it is necessary to define and specify common geoethical criteria. Primarily, it is with engineering ethics that geoethics must clarify its links. Given that the responsibilities of both professions and their training are different, ethical issues often arise much more frequently in the hydrocarbon industry than in mining. This is expressed by a petroleum development geologist:

"Today I'm in a purely exploitation sector, developing fields, there's no more exploration. There are different teams, they are technical teams, I see that they lack a technical gear: the engineers never agree with the geologists. This is like a war and there's a missing gear in the middle, and geoethics, apart from bringing in environmental concepts and social license to operate, of relationship, of responding with skill, talks a lot about… Yes, it may be a delusion for many people, but for me it's the foundation on which I work."

Sorkhabi (2016) argues that there are two cultures in the oil industry, which extend, for example, between upstream and downstream, between geologists and engineers, or even between geoscientists (geologists, geochemists, and geophysicists) and engineers (reservoir, drilling, and production). Here, we rescue this differential perspective of work that is recognized by both geologists and engineers; for example, the latter recognize that reservoir care is a task that the geologist does best, and that the task of the drilling or petroleum engineer is to minimize time and cost,

"perhaps neglecting the reservoir a little." The commandment of performance is always present:

> *"I think the company wants them to be unaware. In fact, every time we finish a well, they show the results that the company obtained as a company. And it's like everyone is... "We successfully completed a record number of fracture stages," they announced, receiving applause from everyone. However, I remain uncertain about these achievements."*

Both mining and petroleum industries require dialogue, interaction, mutual understanding, and cooperation between both professions, as one interviewed engineer pointed out:

> *"We have differences in training and criteria, but ultimately, we are working towards the same goal."*

12. Population awareness and involvement

If we address the issue of geoethics in relation to geoscience professionals, particularly in mining and oil projects, the voice of the communities, whether indigenous or not, is a variable that cannot and should not be omitted.

Jan Boon, a Canadian geologist, in his doctoral thesis noted that companies with open and fluid relationships were more likely to engage neighboring communities through early and sustained interaction (Boon, 2015). However, even in such cases, project managers acknowledged that few companies were willing, or able, to allocate sufficient resources for studies or professional advice. While these insights were made over fifteen years ago, they remain relevant today: as with any cultural or organizational shift, adopting new practices takes time. Moreover, genuine community inclusion cannot be considered seamless if local residents oppose the project's very existence, as exemplified by the case of Esquel in 2004[16], where public resistance led to a provincial law banning mining activities.[17]

The research question guiding his thesis is how relationships with the environment gravitate in mineral exploration in the development of tasks and the perception of benefits and harms, both current and future. It is a fact that if the demonstrations and claims of residents had not occurred, and this in all latitudes, the discussion about

[16] Meridian Gold.
[17] https://mapa.conflictosmineros.net/ocmal_db-v2/conflicto/view/66 (accessed 21 July 2025).

geoethics would still be in an embryonic state. One of the interviewees, a geologist who went through all the changes and began exploring in the 1980s, comments that from the 2000s onwards the role of communities became important, they become a voice that must be heard.

> *"Regarding conflicts with the communities, it emerged that as they obtained information from NGOs or about what was happening in other parts of the world, protests did not occur when they did not have this information."*

An interviewee who has developed their career in the US states that, in addition to technological changes, 'people were also changing, they realized they had the right to know and to have an opinion.' This aligns with the words of Jim Cooney, author of the concept of Social License to Operate (SLO), who affirms in an interview[18]:

> *"I introduced the term, which for me was simply a way to describe a particular situation that had evolved, at a World Bank conference in March 1997. It was to discuss the next 25 years of mining. In those days, in many developing countries, the local communities where we were operating were physically and politically isolated. From that point on, I said that when we deal with the government, we are trying to obtain a government permit, and when we are dealing with local communities, we will call it a social license. From this, they transformed a simple concept into a kind of pragmatic reference point for managing political risks to an ethical concept."*

The almost universal access to the internet, the ability to see in real time what was happening in other mines, and the advice of local and international NGOs contributed to this awakening. In this way, the isolation that communities neighboring mining projects usually suffer from is overcome. This concept is endorsed by another geologist:

> *"Resorting to the media and social networks, there is an act of disguising oneself as an indigenous person to gain benefits. Also, the communities of Salta are able to communicate with those of Mexico. Now, having greater communication, things are changing; they are no longer isolated."*

[18] https://www.youtube.com/watch?v=NkQMq0gIEYU (accessed 21 July 2025).

It's not always about real or potential conflicts with indigenous peoples. This can also happen with communities in urbanized areas, like in Córdoba where decorative rocks are exploited, or in Mendoza in the past, when mining was a more common activity.

> *"But I believe our biggest conflicts have been with middle-class and working-class people. It's more aggressive because they're competitors. Take the case of the Litio 3 Quebradas deposit, it's starting to produce, they've invested capital, and in the valley it's fantastic, there are jobs, but the warehouse owners say, 'These people are paying 3 or 4 times more than us, and we can't pay our harvesters that much.' And they end up claiming that 'the company is to blame for putting a mine next to them to harm them.' I've seen people lie shamelessly, well-dressed people whom you would assume are reasonable… well."*

Regarding the people of Mendoza, the interviewee describes them as follows:

> *"I admire their work ethic, intelligence, and tenacity. They are very determined people, but sometimes their stubbornness can be excessive. I've seen cases where speakers have had to escape through the window to avoid arguments, something quite common there."*

Retired geoscientists experienced changes in how they related to the human environment, as well as shifts in patterns of connection. They needed to adapt to considering the local perspective, and the prevailing attitude in the 80s, "let the people adapt because we have the authorization" to listening and negotiating. Several interviewees have cited cases of community empowerment to such a degree that their demands became non-negotiable requirements:

> *"I have two examples related to oil: one was in Loma La Lata. At a certain point, the Mapuche people denounced cultural damage, material damage, etc. The company was never prepared for this, they had no precedent, they were met with a lawsuit carried out by everyone who was there, organized by a huge law firm. A contract between the company and a German consulting firm surfaced, which subcontracted a local environmental company where I worked. It was an environmental study that we took very seriously, with thoroughness, with all kinds of professionals, even doctors. Meanwhile, the company was doing its ridiculous things: for example, to protect native fauna, they bought an incubator for rhea eggs, they found a paleontological remnant, and they made a small shelter for it, then human remains appeared, and they made another shelter, but it was more serious… the company was wasting money. Meanwhile, the lawsuit*

was progressing. They said that nothing was respected here, they came and drilled wells, there were twelve families, the houses they built for the families! I wish I had them, they gave them a zeppelin of gas per month that lasted them a year. The aid was grotesque. At first, they asked for a meeting and the company's manager was unavailable, so then they started entering the office directly. The escalation continued because from there they would go to the city of Neuquén, and they were in communication with other communities around the world. This was around the year 2000. The doctors made the mistake of sending the raw data to the residents and they were terrified. The demand was extremely high. There was a very negative attitude. Once the temporary structures were finished, they weren't satisfied, and the houses weren't what they wanted either. I've worked on mining projects in Neuquén, and they are insatiable, and moreover, they don't keep their word. There comes a point when you give up, and with this issue, there's no way. On the other hand, what identifies them as Mapuche? They don't speak Mapuche, they're nothing, and they're claiming indigenous rights. You ask them what lands belong to them, and they say everything. Their criticisms are never constructive, they're destructive. They accept everything and want more and more."[19]

According to Cortina (1996), for an activity to gain social legitimacy, it must not only produce the goods expected of it, but also respect the rights recognized by that society and the values it already shares. However, the first inconvenience arises here: "The goods produced by mining are not appreciated by a portion of society. Although minerals are essential inputs for life, large-scale mining is an activity that, in some circles, is at best undervalued, and despised at worst. The impact of a project is often perceived, although not always, as an activity that alters the landscape, produces noise, generates risks such as environmental contamination, water scarcity, etc. It fulfills all the requirements to be denounced by the host populations.'
Cortina continues: 'Therefore, an interaction occurs between the values that arise from the corresponding activity and those of society, between the ethics of that activity and civil ethics, without it being possible to dispense with either of the two poles without becoming delegitimized.' Often the ethics of the activity, if it exists, and civil ethics do not coincide, and this gap can widen if it involves communities of indigenous peoples. However, in some cases, the interviewees account for the

[19] This statement reflects the personal opinion of the interviewee and does not represent the views of the authors. The language used illustrates the depth of misunderstanding and bias that can exist in conflict-ridden settings. From a geoethical perspective, such attitudes pose significant challenges to meaningful intercultural dialogue and the respectful engagement of Indigenous peoples. It is precisely this type of discourse that undermines efforts toward ethical and sustainable project governance.

reasons behind the animosity, which may be based on political motives, the effect of which is amplified by the absence of a communication strategy on the part of the company. The Famatina project in La Rioja (Argentine), for example, which was abandoned in the advanced exploration stage:

> *"(The then national government) questioned everything (La Rioja province governor) Maza had done, including the contracts for the mining reserve areas, and in this case, Barrick fell. The signs began to appear: 'Hands off Famatina', 'Water is worth more than gold', and they began to mobilize all state forces, municipalities, teachers, police, all carrying out the worst kind of terrorism. I had an assistant in Famatina, we worked with 4 young men from there, they had experience because they had previously worked in exploration, and one had two children who had to change schools because they made life impossible for the children, at school events there were banners related to the mine. In the end, they cut off the access road to the mine… this was also a problem for the company… I would talk to the head of Institutional Relations for Veladero, who was the company's representative for San Juan, he was a doctor, and I would say to him, "Doctor, when are you going to come here because people are talking?", and he would say, "I'll be there soon, don't worry." This man was in San Juan, primarily focused on Veladero and didn't understand the difficulties and urgencies of an exploration project. They didn't authorize us to communicate anything, they told us that as explorers we had to work in the field, that the experts were the ones who communicated, that they would come, they would come… So, the rumors started to circulate, we would take out the trash, they would give us a certificate, and we would throw it in the landfill that we had available in the municipality. And people started spreading crazy rumors, like that we were carrying gold in the bags… or that the cyanide was being dropped off in helicopters at night, that's why we didn't know (because of the population), that the guanacos were bald up there, but the guanacos were fat next to the camp, if nobody touched them, they also said that we bathed in the camp with imported mineral water… that's how they cut off the road for us… In the end, they just insulted us as murderers, I'll never forget it because we had been careful that not even a drop of oil fell in the camp, honestly, it made me very sad and angry. The project was abandoned, and today it could be producing and generating wealth for the province and the country."*

This testimony illustrates the personal perspective of a geologist who experienced the Famatina conflict from inside the exploration project. However, the residents' opposition, which manifested in the well-known slogans "Water is worth more than gold" and

"Hands off Famatina," was rooted in broader concerns about water use, lack of public participation, and perceived environmental risks. While some rumors may have been unfounded, the failure of the company and public institutions to engage transparently with the local population contributed to escalating tensions. From a geoethical standpoint, the absence of timely, honest, and accessible communication allowed misinformation to flourish and ultimately led to the abandonment of the project.

Another motivation for opposing mining activity, one that does not arise from a conflict between civil ethics and sector-specific ethics, is the presence of economic interests, which can be understood as intersectoral competition. Several testimonies substantiated the hostility towards mining in Mendoza as a matter that could be characterized as petty. It is a wealthy province with large, cultivated areas, hydrocarbon resources, and the passage to Chile as a logistical advantage over San Juan, and it is a point of attraction for tourism. In general, jurisdictions that are strong in activities such as agriculture and tourism perceive mining as a threat.

> *"Because it's easy to instill fear in the general public, who are unfamiliar with a new industry like mining, and to create the fear in people of 'they're going to leave us without water,' we won't be able to have vines, people are going to die, etc. My mother's aunt lives in Mendoza (Argentine) and she has often spoken to me and told me: 'Pablo, you who work in mining that pollutes.' The same thing happened here in San Juan with the winemakers, but not because of the water, Veladero is in another basin, it's not the San Juan River basin, there's no way… their economic situation is out of balance. They come with marginal profits, they pay by the bucket that the harvesters fill, they pay it in cash, for a pittance, so then the mining companies come with very good salaries, with people on the payroll, with social benefits…"*

This account highlights the socio-economic dynamics and perceptions that fuel local resistance to mining. While some fears may be based on misinformation, they reflect real concerns rooted in economic insecurity and distrust. These tensions underscore the importance of proactive engagement and transparency by mining companies. Responsible mining involves not only technical mitigation measures, especially regarding water, but also clear, honest communication with affected communities. The early incorporation of geoethical principles can help build trust and reduce conflict potential.

13. Personal values are expressed in the professional field

Geoscientists, particularly in oil and mining exploration, often work in remote environments, far from urban centers and corporate headquarters. Unlike other professionals, they engage directly with nature, isolated communities, and landowners, developing a perspective shaped by on-the-ground realities. Their proximity to the field makes them the first point of contact between companies and local populations, even though official roles may not explicitly include community engagement (Boon, 2015). This disconnects between field and executive levels can lead to communication gaps and ethical dilemmas. Field professionals are often in a better position to anticipate the social or environmental consequences of a decision, sometimes more clearly than managers located in distant offices. A misstep at this early stage can jeopardize not only a project's reputation but also its operational viability.

The *de facto* autonomy that professionals in the field have allows them to make judgments based on their expertise and values, and as a result, filter communication with their superiors to achieve good results. In this case, a geologist who is an exploration manager:

> *"You may be under pressure from the company, but you also know that if you make a mistake, the entire project could be halted. It is one thing to be under pressure, and another to act like a professional and understand that because of your mistake, the whole project could be stopped. It's no longer... in my case, when I was in management and with the team in the field, I preferred to take one or two more days, and then when I communicated with Buenos Aires, I painted a situation that wasn't entirely real, but I preferred to take my time, talk, see how to move forward, but for the benefit of everyone. With respect to the communities and with respect to the results. Sometimes the technical part became totally secondary, and even beyond. The progress and the connection were much more important... that's why I did well and ended up going to advance the projects. Once you do that work, the relationship becomes smoother and flows faster, but you have to invest time, and the board has to take that into account. It doesn't have high costs for the company, although from a technical point of view they would like to move much faster."*

A similar strategy was applied by a geologist in a salt flat area, with the mission of facilitating the relationship with the communities:

> *"The things I did with the community, mediating and bringing positions closer together, are very logical things to understand... I would say there's no science*

to it. And I went to the extreme of understanding the business logic and understanding that time and money, for them, is logical. To reach an agreement, more than to unblock something that was blocked, sometimes I would tell them and threaten them, saying, 'If we don't give them this, I assure you they won't sign.' And deep down, my real interest was to bring the benefit to the people."

The "landscape" to face may be varied, but there are common denominators that must be respected, although they do not guarantee the result. The unwritten manual of good conduct in the field prescribes behaviors as simple as greeting the inhabitants and introducing oneself, notifying them if you are going to be traveling in the area frequently, driving at a slower speed on dirt roads, listening to them, respecting the slower pace of some communities, and even visiting them in their homes if the bond strengthens. One of the interviewees, now retired, defines geologists as ambassadors of the company, with all the weight that this title implies. The values individuals carry from their family life are also put to the test, as a former exploration manager recounts:

"In the case of professionals and the environment, the moral question is inherent. Our family education led us to behave in a certain way. When I started, we never left trash anywhere, we never soiled anything, we never stopped caring about the environment, not just in theory, but in the sense of preserving nature and humanity. I've been isolated in a post, totally isolated, where basically there were people who had a life similar to that of the goats they cared for. With a life lacking even the most basic necessities. And the only thing we did with them was to provide them with some things like colored pencils for the little ones, or cans of food or clothes, whatever it was."

Another geologist shares a similar experience:

"We have to take care of the relationship with the people. The people are the owners of the place, so the company has to be respectful. I was a scout, we had a headquarters here in Don Bosco with the Salesians... you can't come and explain to me what environmental care is, at least the basics. We had a principle, "the scout leaves no trace." We would go camping and the place had to be better than when we found it, we left no trace, there was no trash. It was easy for me. It was useful when I had to train the people I was in charge of."

Mining shares many facets with the hydrocarbon industry. Geologists, in particular, find opportunities to showcase their values in relation to their colleagues and the few

inhabitants with whom they can interact, as well as in relation to the environment. The development of the activity might not meet acceptable technical standards and could directly or indirectly harm aquifers. A geologist in charge of a reservoir emphasizes the importance of not ignoring safety and environmental standards at their workplace. She insists that if supplies like pipes or cement run out, they must be replaced immediately because cutting corners is not an option. This is crucial not only to comply with regulations but to protect the environment and the nearby communities that rely on the area's resources:

> *"I can tell you that where I am, it's very important not to turn a blind eye to that and every time I communicate with the drillers, I say, we have to make sure we reach this level. Well… but if I don't have more pipes, if I don't have more cement, No. If you don't have more pipes, you bring them, if you don't have more cement, you buy it, but those things can't be negotiated. Not only because we make a statement and send it to the province, but because the integrity, the contamination, is at stake, so not only can't you stop, but how many towns do you supply? There are 3 towns nearby, within a 25 km radius!"*

However, the observant performance of best practices should not be left to private virtue, to the values that professionals bring as a product of their family education and their history. When interviews are conducted, it is usual for examples to arise that illustrate the topics that, in many cases, spontaneously come to mind for those consulted, anecdotes and examples, but this is not the case in others. This can occur for various reasons: a reserved attitude that does not want to provide concrete data, or a lack of sufficient case law to support a statement.

14. Business and geoethics are not synonymous

There is an ecological consciousness, driven by demands for quality and healthy products that has contributed to a certain moralization of production and consumption processes, guiding supply and demand towards clean technologies. Ecological consensus has not halted the pursuit of growth and individualistic consumption; on the contrary, it has led to the production of goods and services that meet certain environmental standards, as well as the emergence of a consumption-based ecology. One of the references regarding this turn is that investors are asking the finance sector of companies *"what are you doing about sustainability*?" These changes are illustrated by the testimony of an interviewee:

> *"We started getting into the sustainability topic this year. In fact, some of the more advanced suppliers are starting to ask questions. They want to know about the entire value chain and are starting to ask: 'Tell me what you're doing in order for me to sell to you…' I don't know if they've reached the point of saying 'if not, I won't sell to you,' but they're heading in that direction. The seller and the buyer are the ones who set the market conditions, regardless of regulations or standards. The risk of not adapting lies in the question: what do you do with the product if no one buys it? And those who won't buy it are international companies or governments."*

While this testimony demonstrates an increasing awareness of sustainability in market dynamics, it also highlights the ambiguity surrounding the term. "Sustainability" is frequently invoked for different, and sometimes contradictory, purposes. In the context of natural resource exploitation, the concept is often used to align with global market expectations or regulatory frameworks, but not always with a deep ethical commitment to intergenerational or ecological responsibility. This ambiguity raises the need for a more rigorous and shared definition of sustainability, one that can hold companies accountable beyond compliance and marketing narratives, and that aligns with geoethical principles.

Hemianopsia is a pathology that prevents one from seeing half of the visual field. All industries, and particularly those related to the exploitation of natural resources, have suffered from it, and in some cases it still persists. Mining and oil have historically privileged the visual field that corresponds to productivity, a concept that summarizes applied science, efficiency, technology, and capital endowment. However, the other half of the visual field has not been perceived, the one that involves the industry's relationship with the environment, the relationship with the human environment, and in general, placing humans at the center of mining or oil activity. The shift and incorporation of business ethics have occurred due to the moral consciousness of those affected, who gradually gained ground and managed to organize. Hemianopsia still persists in some enclaves, but it is no longer accepted without question. Lipovetsky (1992) illustrates it in a stark way: *"the world of business succumbs to the unexpected charms of values, it seeks a soul, of ethical businesses*." The risk is that what is applied is a 'painless ethics,' as the author himself calls it, that is, formal, written in protocols, audits, codes of conduct, but with loopholes to circumvent these guidelines when it is not convenient. This is exemplified by an oil professional:

> *"We have standards and regulations, procedures, and national laws, and the company has to comply with them. But they tell you that you have to be quick*

on your feet,' meaning that you have to look at each situation and say, 'We're outside of the standard here, we can't do this like that, but if we don't… everything is going to come to a standstill."

This selective blindness – what we have referred to as institutional hemianopsia – reflects the tendency to focus exclusively on technical efficiency and financial performance, while ignoring broader environmental and social costs. In this sense, the adoption of "painless ethics," as Lipovetsky (1992) describes, often translates into formal compliance mechanisms devoid of substantive change. A more transformative approach would involve the application of full-cost accounting, a method that internalizes environmental degradation, social disruption, and long-term liabilities into the economic valuation of projects. By integrating ethical reflection into accounting practices, this model could help rebalance the visual field of extractive industries and align corporate behavior with geoethical principles.
An example of the existence of hemianopsia is the plugging and abandonment of oil wells, which is very costly. When a well reaches a certain level of maturity, it is strategically sold to smaller companies whose operations have lower costs, and the production volume is also lower, thus making its exploitation still profitable. In this way, large companies sell wells nearing depletion to smaller companies that buy them, but then they become environmental liabilities whose remediation costs they will probably not finance. This is a big difference with the mining industry, which plans the closure, generally at the beginning of the mine's life:

"Well, if I operate a well and things go wrong, there's a remediation process, I have to condition it in a certain way, I have to comply with certain regulations, make sure the aquifers are well isolated, but that's the case for a current well. But in very mature fields that are nearing the end of their useful life, that's a problem that no company wants to take on. What they usually do is, if I have 400 wells, and I have about 200 to abandon, then I do about 20 per year, little by little, and I abandon them… From the company's point of view, it's an expense. And since it's an expense that is not regulated or controlled, it's an expense that they keep kicking down the road."

It is important to highlight that the provincial authority[20] participates in the process with the function of monitoring abandonment. Companies are required to declare production and notify the imminent depletion of wells. However, declaring a well as "abandoned" involves incurring high costs. An evasive strategy that they use

[20] Neuquén, Argentina.

in these cases is to inform the province that the well is "under study," even though it is actually abandoned. This behavior, which is practiced discreetly, confirms a maxim cited by one of the professionals consulted: the company doesn't extract oil, it extracts money. Here, the responsibility of the local authorities cannot be overlooked, since they are charged with controlling whether a well is abandoned or under evaluation. This fact is important as it will determine if stricter control measures are required.

> *"... And I'm telling you, it's going to be a big problem in ten years, when they start taking over these old oil fields in Neuquén, which are being passed from company to company..."*

Everything discussed concerns business ethics, that is, the responsibility of companies. It is central to what is written in documents and standards that support good practices, such as corporate declarations of principles, and geoethics applied to professionals in their daily work. This paper focuses on analyzing to what extent the notions of responsible mining or corporate social responsibility align with geoethics. There is abundant material available at the institutional level, but not so much when it comes to compiling the experiences of geoscientists.

Business ethics is guided by profit and image objectives. Lipovetsky (1992) affirms that the policies designed and implemented by companies, such as environmental ethics, are motivated by interests, responding to a new paradigm that is already globally dominant. It is true that benefits are anticipated from clean technologies: that is why they can advance and develop. Certainly, positioned at the opposite end of the spectrum from those who pursue profitability at all costs are certain environmental activist groups, for whom the moral imperative to protect nature overrides other human-centered obligations. Their ethical framework is rooted in ecocentrism (the belief that nature has intrinsic value independent of human utility) which leads them to prioritize environmental preservation even when it may conflict with immediate economic or social concerns. As a result, they may focus more intensely on issues such as biodiversity loss, pollution, and the depletion of the ozone layer, sometimes placing less emphasis on pressing human challenges like poverty, underdevelopment, or unemployment. This stance, while often criticized for neglecting human needs, can also be understood as a response to the historical marginalization of ecological concerns in public policy and industrial development. In their view, long-term planetary health is a prerequisite for sustainable human wellbeing.

15. Conclusions

This study reveals the fragmented and often improvised ways in which Earth Science professionals navigate ethical dilemmas in extractive industries. Despite the absence of formal geoethics training, many practitioners act according to internalized values and experience-based judgment, especially when operating in isolated or high pressure environments.

The findings show that the concept of geoethics is largely unknown or underdeveloped among professionals, yet its practical relevance emerges in multiple dimensions: decision-making under uncertainty, interactions with communities, environmental stewardship, and personal accountability. The recurring contrast between corporate discourse and on-the-ground practices highlights a critical ethical gap that cannot be bridged by regulations alone.

One of the study's central insights is the prevalence of a reactive ethics model, a pattern where ethical frameworks are adopted only after crises or social conflict. This dynamic underscores the urgent need to shift from reaction to prevention, from policy as image to ethics as culture.

The 1990s marked a turning point for the mining sector in Latin America, with the entry of foreign capital, stricter safety standards, and increased attention to environmental issues. Yet even today, ethical tensions persist, especially in junior companies and in upstream oil operations, where professionals often lack institutional support and rely solely on personal judgment.

The role of universities is pivotal. Curricula in geology and mining engineering must move beyond technical and legal instruction to include geoethics as a transversal component, preparing future professionals for the social and environmental complexity of their work. Likewise, companies must ensure that ethical policies are effectively implemented, monitored, and aligned across all levels of decision-making.

Ultimately, geoethics is not just about knowing what is right, it's about being empowered to act on it. This requires a shared commitment across academia, industry, and governance to foster a professional culture grounded in ethical awareness, scientific responsibility, and human dignity.

16. Recommendations

- Integrate geoethics systematically in Earth Science education, including real-world case studies.
- Promote internalization of ethical principles across all company levels, not just compliance.

- Recognize the strategic role of field professionals as key actors in maintaining social legitimacy.
- Shift from a culture of reaction to one of ethical anticipation and shared responsibility.
- Geoethics must evolve from abstract principle to lived practice, anchored in education, supported by institutions, and embraced by professionals who often operate far from the spotlight, but at the heart of critical decisions.

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References

Álvarez-Gayou Jurgenson, J.L., (2003). Cómo hacer investigación cualitativa: Fundamentos y metodología. Paidós, Ecuador. Retrieved from: http://www.derechoshumanos.unlp.edu.ar/assets/files/documentos/como-hacer-investigacion-cualitativa.pdf (accessed 21 July 2025).

Ayeh, D., Bleicher, A., (2021). One concept fits it all? On the relationship between geoethics and responsible mining. The Extractive Industries and Society, 8, 100934. https://doi.org/10.1016/j.exis.2021.100934.

Boon, J., (2015). Corporate Social Responsibility, Relationships and the Course of Events in Mineral Exploration – An Exploratory Study. PhD Thesis, Carleton University. Retrieved from: https://carleton.scholaris.ca/items/5f8e7ce3-0972-4ee0-a5df-5128e7cb3868 (accessed 21 July 2025).

Boon, J., (2020). Relationships and the Course of Social Events During Mineral Exploration: An Applied Sociology Approach. SpringerBriefs in Geoethics, Springer International Publishing. https://doi.org/10.1007/978-3-030-37926-1.

Borda, P., Dabegnino, V., Freidin, V., and Güelman, M., (2017). Estrategias para el análisis de datos cualitativos. Buenos Aires: Instituto de Investigaciones Gino Germani, Facultad de Ciencias Sociales, Universidad de Buenos Aires. Retrieved from: https://iigg.sociales.uba.ar/2019/11/07/his-2-estrategias-para-el-analisis-de-datos-cualitativos-2017/ (accessed 21 July 2025).

Cech, E.A., Metz, A., Smith, J.L., and deVries, K., (2017). Epistemological Dominance and Social Inequality: Experiences of Native American Science, Engineering, and

Health Students. Science, Technology, & Human Values, 42(5), 743-774. https://doi.org/10.1177/0162243916687037.

Cortina, A., (1996). El estatuto de la ética aplicada. Hermenéutica crítica de las actividades humanas. Isegoría, 13, 119-127. https://doi.org/10.3989/isegoria.1996.i13.228.

Foss, S.E., (2019). Geoethics in the Field: Leading by Example. Earth Magazine. Retrieved from: https://www.earthmagazine.org/article/geoethics-field-leading-example/ (accessed 21 July 2025).

Herkert, J.R. (2005). Ways of thinking about and teaching ethical problem solving: Microethics and macroethics in engineering. Science and Engineering Ethics 11(3), 373-385.

Lencina, R., (2017). Social responsibility: A new challenge in graduate university education. Annals of Geophysics, 60. https://doi.org/10.4401/ag-7559.

Lipovetsky, G., (1992). El crepúsculo del deber: La ética indolora de los nuevos tiempos democráticos (translated from French: *Le crépuscule du devoir: L'éthique indolore des nouveaux temps démocratiques*, ed. Éditions Gallimard, París, 1992). Editorial Anagrama, Barcelona. Retrieved from: https://sinismos.wordpress.com/wp-content/uploads/2012/09/53292636-gilles-lipovetsky-el-crepusculo-del-deber-la-etica-indolora-de-los-nuevos-tiempos-democraticos1.pdf (accessed 21 July 2025).

Peppoloni, S., and Di Capua, G., (2021). Current definition and vision of geoethics. In: Bohle, M., and Marone, E., (Eds.), Geo-Societal Narratives: Contextualizing Geosciences (pp. 17-28). Palgrave Macmillan. https://doi.org/10.1007/978-3-030-79028-8_2.

Smith, J.M., (2019). The ethics of material provisioning: Insiders' views of work in the extractive industries. The Extractive Industries and Society, 6(3), 807-814. https://doi.org/10.1016/j.exis.2019.05.014.

Sorkhabi, R., (2016). Petroleum geologists and engineers: bridging the two cultures. First Break, 34(10). https://doi.org/10.3997/1365-2397.34.10.86970.

Sánchez Albavera, F., Ortiz, G., and Moussa, N., (1999). Mining in Latin America in the late 1990s. CEPAL – Natural Resources and Infrastructure Division, United Nations Publication, LC/L.1253-P, Series "recursos naturales e infraestructura", Santiago, Chile. Retrieved from: https://repositorio.cepal.org/server/api/core/bitstreams/f936e48c-4ee5-45a8-93c7-b9485808c5c0/content (accessed 21 July 2025).

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