

# Coal Ontography and Youth Perspectives: Exploring Landscape Transformation in the “Muskauer Faltenbogen” Through Geology

Polina Ivanova-5002451, Viny Purnama-5010045, Peilin Lu-5006953, Adarsha Reddy-5010025

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## ABSTRACT

This project investigates the ontography of carbon (in its form as coal), using the Muskauer Faltenbogen Geopark as a case study to explore the material's role in landscape transformation. Carbon, often reduced to a chemical element or a resource, is reimagined here as an active agent influencing both geological and human systems. The project focuses on how carbon shaped the region's history—from its geological formation during the Pleistocene epoch, to its extraction as lignite in the industrial era, and its current role in environmental restoration. By reframing coal as a central figure in the landscape, this study seeks to highlight its complex, multifaceted role in co-producing natural and cultural processes.

A key component of the project is a participatory "Coal Diary" workshop involving young people aged 16-18. The workshop engages participants in creative exercises such as storytelling and collage-making, allowing them to explore coal's role across different historical periods. They will imagine coal's "life" during the geological formation of the Muskauer Faltenbogen, its role in industrial mining, and its current environmental impact. This participatory methodology aims to offer new, youth-driven perspectives on carbon's significance, fostering a more dynamic understanding of how this element shapes landscapes and communities.

The outcomes of this project will not only deepen the understanding of coal as an active force but also contribute to broader discussions on environmental restoration, extractivism, and sustainable management. By integrating ontographic methods and youth participation, this project challenges conventional views of coal, positioning it as a co-producer of landscapes. The stories, reflections, and visual collages created by participants may also be showcased in museum exhibits, further promoting public engagement with the idea of carbon as a vital element in both natural and industrial histories.

Polina Ivanova, Viny Purnama,  
Peilin Lu, Adarsha Reddy

Brandenburgische Technische  
Universität, Cottbus

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## **1. INTRODUCTION**

### **Background**

The aim of the project is to explore a seemingly well-known material, carbon (in its form as coal), from a fresh perspective, situating it within the framework of ontography. Carbon, while traditionally summarized as a chemical element and the fourth most abundant in the universe after hydrogen, helium, and oxygen [Loeve, Vincent, 2017], has over the past few decades become central to broader discussions on topics such as climate change and globalization. Through ontography, we aim to give voice to previously overlooked entities like coal, extending the work of scholars who advocate for a shift in focus away from human-centric viewpoints [Johnson and Latour, 1988].

Coal, a carbon-rich material, has been a cornerstone of both natural and industrial history. Formed over millions of years, coal has not only fueled industrial revolutions but also significantly shaped geological landscapes. The Muskauer Faltenbogen, an area between Germany and Poland, provides a compelling case study of coal's dual impact—driving socio-economic development while leaving a lasting environmental footprint. As global focus shifts toward environmental restoration and sustainability, understanding coal's historical and ongoing influence is more critical than ever. This project, through its participatory and ontographic approach, aims to contribute to that understanding.

### **Research Objectives**

The primary objective of this research is to explore how coal, as a material deeply embedded in both geological and industrial systems, has shaped the landscape of Muskauer Faltenbogen. This study seeks to offer new perspectives on coal's role in landscape transformation through an ontographic approach, which examines the relationships between natural materials, industrial activities, and human experiences. An essential component of this research is the "Coal Diary" workshop, where youth participants engage creatively with coal's historical, present, and future significance. By integrating their perspectives and creative outputs, such as collages and stories, the study aims to rethink how coal is perceived, particularly about landscape recovery and ecological renewal.

### **Research Question**

This research is driven by the following key questions: What role has coal played in shaping the geological and industrial landscape of the Muskauer Faltenbogen area? How can youth perspectives and creative methods with an ontographic approach contribute to new understandings of coal's influence on landscape transformation and ecological recovery? These questions aim to uncover the interconnected dynamics of coal, human activity, and environmental change while highlighting the value of participatory approaches in reimagining future landscapes.

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## Research Limitation

This study faces several limitations that may affect the generalizability of its findings. The focus on the Muskauer Faltenbogen area limits the scope to a specific geographical area with a unique coal mining history, which may not fully represent other areas with different industrial or environmental contexts. Additionally, the subjective nature of interpreting creative outputs from the youth workshop poses challenges, as the qualitative data derived from stories and collages can be open to varied interpretations. Furthermore, while the study explores coal's role in landscape transformation, it does not extensively compare coal with other fossil fuels or renewable energy sources, which could provide a broader understanding of energy transitions. Despite these limitations, the research offers valuable insights into coal's complex role in both human and non-human landscapes.

## 2. THE INTERCONNECTEDNESS OF COAL, NATURE, AND CULTURE: Exploring the Ontological Turn

Since the mid-20th century, under the backdrop of industrialization, modernization, and globalization, humanity has transitioned from the "Holocene" to the current geological epoch known as the "Anthropocene," a term proposed by geochemists Paul Crutzen together with his colleague Eugene Stoermer in a discussion. In recent years, issues such as global climate anomalies, ecological degradation, depletion of natural resources, and a sharp decline in biodiversity have become increasingly frequent, causing severe impacts worldwide. These changes have drastically altered the survival conditions of various species and reshaped the potential future of humanity. Under this contradictory crisis, "Anthropocene" has been a revolutionary awakening across multiple disciplines to re-examine the relationship between humanity and nature. Furthermore, there is a growing call for exploration into energy transition and various resource extraction and experimental methods. These developments reflect the specific relationship between humanity and the environment across time and space. Consequently, the interaction between coal and the environment, along with its interactive status, has become a focal point of interest for us.

Historically, methods for understanding the relationship between nature and culture were primarily based on empirical rules. However, with the emergence of scholars like Bruno Latour<sup>1</sup> and many others, it has been demonstrated that our thinking is no longer solely based on a fundamental distinction between humans and non-humans. This new understanding does not simplify non-humans to mere environmental functions, nor does it reduce their attributes to symbolic projections of human emotions. This approach diverges from long-standing notions that made it inappropriate to view machines, mountains, or inorganic materials as self-referential entities.

Bruno Latour argues that nature and human culture, morality, and ethics cannot be distinctly separated. He posits that the boundaries between nature and society are

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<sup>1</sup>Latour, B. (1993). *We have never been modern* (C. Porter, Trans.). Harvard University Press.

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blurred and that all entities (including humans and non-humans) interact within a constantly evolving network of relationships. He emphasizes that society and nature are interdependent, and this dependency is dynamic.

Furthermore, Hinchliffe, in his work *Geographies of Nature*<sup>2</sup>, mentions that nature and human society are interwoven, asserting that nature is not an independent entity but a co-produced phenomenon closely linked to society, culture, and politics. This implies that human actions influence the definition and existence of nature. Nature is a plural and dynamic concept, with different cultures and societies having varying understandings and practices regarding it.

Brazilian anthropologist Eduardo Viveiros de Castro introduces the concept of the ontological turn through his research on the Tupi-speaking Indigenous people. He contrasts their worldview with the Western Enlightenment idea of "one nature, many cultures." In the Western perspective, humans share a common biological foundation (nature), but diverse cultures lead to different ways of understanding the world. This implies that while human cultures vary, there is a single, objective natural world that everyone perceives differently.

However, de Castro found that the Amazonian Indigenous cosmology operates on a principle of "one culture, many natures." In this view, both humans and non-human animals share a similar cultural framework, including cognitive patterns and conceptual systems, but perceive the world differently based on their physical bodies. For instance, humans see cassava beer as beer, while jaguars, sharing the same cultural practices, perceive it as blood. These differences are not about diverse perspectives on the same object but about entirely different worlds being perceived by different beings.

This idea, termed "multinaturalism," suggests that the world consists of multiple natures as experienced by various beings, rather than one nature understood through different cultural lenses. Through this lens, the Amazonian worldview challenges the Western notion of a single, objective nature, presenting a richer, more varied ontological understanding of reality [Viveiros de Castro, 1998].

Despite the various directions of the ontological turn, the "ontological turn" fundamentally addresses: first, the implications of the basic assumption of "different worlds" regarding what is considered "real"; and second, the presupposed opposition between "culture" and "nature." We attempt to use philosophical ontology as a means of understanding to consider how it can be applied in workshops, allowing us to perceive the realities and phenomena presented by young people regarding coal.

The multi-species ethnography represents a continuation and breakthrough of the ontological turn, focusing on cultural writing in the Anthropocene era. It addresses the reshaping of relationships between humans and other partners and unfamiliar species on Earth, responding to the crises that frequently arise in the current era of globalization. This approach allows for the exploration of various relationships across diverse spaces and contexts. For example, in *Mushroom at the End of the World: On*

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<sup>2</sup> Hinchliffe, S. (2007). *Geographies of nature : societies, environments, ecologies*.

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*the Possibility of Life in Capitalist Ruins*<sup>3</sup>, the author connects people, objects, and cultures from around the globe through the matsutake mushroom, illustrating the dialogues and relationships that emerge during encounters with this species. As the author states, "History, whether made by humans or non-humans, should be a multifaceted record of world creation." This cross-narrative method effectively demonstrates that the human world is neither singular nor isolated; rather, it is shaped by the cooperation and needs among species, resulting in a symbiotic and mutually beneficial model that constructs landscapes. Perhaps this is what we can look forward to how narratives about coal from young people in different countries might shape their understanding of the relationship between coal and the environment.

Building on these theoretical foundations, the article *The Multiple Signatures of Carbon*<sup>4</sup> provides some insights for our research. Ontology and Ontography will be introduced into our study. Ontology is a branch of philosophy that deals with the nature of being, existence, and the categories of being. In the context of coal, the ontology of coal would involve examining the fundamental nature of coal as a substance, its properties, classifications, and the relationships it has with other entities in the environment. Ontography is a method that explores the multiple modes of existence of things and their interactions, without aiming for a singular, unified definition. It adopts a descriptive approach, emphasizing the coexistence of these various modes rather than deriving them from a fundamental definition. The primary goal of ontography is to articulate the diverse signatures of entities, thereby outlining the contours of our shared world, instead of seeking a singular unity among them.

### **3. ONTOGRAPHIC APPROACH AND WORKSHOP: Tracing the Journey of Coal**

The ontographic approach to studying coal emphasizes documenting the complex relationships between coal, geology, and human activities over time. This methodology recognizes coal not merely as a fossil fuel but as a multifaceted entity that interacts with various geological formations and human practices. By examining coal through an ontographic lens, researchers can explore its multiple signatures, which include its geological origins, its role in energy production, and its impact on local and global economies.

#### **Workshop Activities**

The workshop begins with an introduction explaining the goals of the activity - to personify coal and trace its journey through different stages, from ancient plant life to modern industrial use and environmental consequences. Participants are invited to imagine themselves as coal pieces, living through various historical periods.

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<sup>3</sup> Tsing, A. L. (2015). *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins*. Princeton University Press.

<sup>4</sup> Sacha Loeve, Bernadette Bensaude-Vincent. The multiple signatures of carbon. Bernadette Bensaude Vincent; Sacha Loeve; Alfred Nordmann; Astrid Schwarz. Research objects in their technological setting, 10, Routledge, 2017, History and philosophy of technoscience. fflalshs-01507185f

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Our team developed a special format to engage the young adults who participated in the International Geopark Camp for Youth. This is a camp for teenagers from different countries, which is organized based on the Muskauer Geopark. The workshop was held for 2 hours as part of the week-long camp program. There were 23 attendees at the workshop and the average age of the participants was 15 years old. The participants were divided into three teams to work.

### **First Step: Personal Perceptions and Group Assignments**

Participants start by answering a few questions to record their perceptions of coal, such as how they would describe it in two sentences, write three keywords that characterize coal today and in the past, and reflect on coal's role in different eras. The discussion then focuses on how these themes relate to the Muskauer Faltenbogen area, including its geological formations and mining history.

After the initial questions, participants are divided into three groups. Each group is assigned to create a story from the perspective of coal during a specific period:

- 1. The geological formation of the park**
- 2. The active period of coal mining**
- 3. The present-day**

### **Second Step: Storytelling and Creative Collages**

In the second part of the workshop, participants develop stories about coal's journey and illustrate them through creative collages. Using A3 paper, pre-prepared photos, and on-the-spot drawings with colored pencils and markers, the groups create vivid images that bring their narratives to life. This hands-on process engages participants in visually representing the complex story of coal.

The stories follow coal's transformation from ancient plant life to coal through geological processes, its extraction and use during the Industrial Revolution, and its impact on pollution and climate change. This narrative approach encourages participants to critically reflect on coal as both a valuable resource and a contributor to environmental challenges.

The collages highlight key moments in this "coal diary," using magazine cutouts, drawings, and digital images to depict scenes such as ancient forests, coal mines, factories, and polluted landscapes. These visual representations capture participants' understanding of coal's role in shaping both the environment and society.

### **Methods and Analysis in the Workshop**

In the workshop, participants will share their stories about coal, reflecting on its historical and contemporary roles. These narratives will be recorded during group discussions and presentations, providing a rich qualitative dataset that captures personal insights and collective understandings. Meanwhile, the creative collages made by participants will serve as visual representations of their stories, incorporating images, drawings, and other materials that vividly illustrate key moments in coal's

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journey, allowing for a multi-dimensional understanding of its impact on society and the environment.

For data analysis, the recorded narratives and participant reflections will be examined using thematic analysis to identify common themes, patterns, and insights related to coal's historical significance, its current role, and participants' emotional connections to it. By interpreting these narratives, we can gain a deeper understanding of how coal is perceived and its multifaceted impact on human and environmental systems. Additionally, the analysis of the visual collages will help us understand how participants represent coal's journey and significance, exploring the imagery, symbols, and narratives depicted in the collages to reflect broader societal attitudes towards coal.

#### **4. CASE STUDY: Muskauer Faltenbogen Geopark**

##### **Geological Background**

The Muskauer Faltenbogen (Muskau Arch), located on the Germany-Poland border, is a geologically significant formation shaped during the Pleistocene epoch, primarily by ice sheets during the Saalian glaciation. This process caused folding and faulting of underlying sediments, resulting in unique features like moraine formations, eskers, and other glacial deposits.

A key aspect of the region's geological history is the accumulation of organic material during interglacial periods, which eventually formed lignite coal. Peat bogs in lowland areas were compressed over time, creating extensive lignite deposits that later fueled the region's industrial development.

Carbon's role in the Muskauer Faltenbogen is central. It is naturally stored as lignite, representing millennia of geological processes, and later extracted by humans, linking the region's natural history with its industrial and economic growth. This relationship exemplifies carbon ontography, which explores how carbon influences both Earth's surface and human societies.

##### **Industrial History**

The discovery and subsequent mining of lignite in the Muskauer Faltenbogen marked a significant turning point in the region's history. By the 19th century, industrial demand for coal drove the establishment of large-scale open-pit mines, transforming the natural landscape into an industrial zone. The extraction of lignite fueled the rapid industrialization of the area, contributing to the growth of local economies and the development of mining technologies.

However, The socio-economic benefits of carbon extraction are often accompanied by severe environmental consequences [Hinchcliffe, 2007]. The coal mining activities in the Muskauer Faltenbogen led to widespread deforestation, the destruction of habitats, and significant changes to the region's hydrology. Some of the most

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immediate environmental impacts were soil erosion, water contamination from heavy metals, and air pollution from coal dust and combustion products.

The socio-economic effects of carbon extraction were equally profound. While mining provided employment and supported the local economy for decades, it also created a dependency on a single industry. When the coal mining industry declined in the latter part of the 20th century due to shifts in energy markets and environmental regulations, the region faced economic challenges, including unemployment and depopulation. This history reflects the complex relationship between natural resource exploitation, economic development, and environmental degradation.

### **Post-Industrial Landscape and Ecological Recovery**

As coal mining in Muskauer Faltenbogen ended, the region underwent a significant ecological recovery, transitioning from an industrial to a post-industrial landscape. Efforts focused on restoring natural habitats, reclaiming open-pit mines, and implementing sustainable land use practices. These projects have helped restore environmental integrity while acknowledging the area's industrial past, demonstrating the region's resilience and ability to foster ecological diversity and sustainable development [Hinchcliffe, 2007].

Reclamation projects have transformed former mining sites into lakes, wetlands, and green spaces, significantly increasing biodiversity. The restoration involved removing mining infrastructure, reshaping the land, and reintroducing native vegetation. These rehabilitated areas now provide habitats for various species, including birds, amphibians, and plant life. The lakes and wetlands formed through these efforts have stabilized local hydrology and supported the regeneration of native ecosystems, while also mitigating soil contamination and erosion caused by previous mining activities.

In addition to ecological restoration, the region has integrated its industrial heritage into its tourism strategy. By developing the area into a Geopark, Muskauer Faltenbogen allows visitors to explore its unique geological formations alongside the remnants of its mining history. Guided tours, museums, and educational programs highlight the region's geological and industrial significance, blending ecological recovery with cultural preservation.

The concept of co-production is central to the landscape's transformation, showing how human and natural forces shape the environment. In Muskauer Faltenbogen, this co-production is evident in how the landscape was first shaped by glaciation and industrial mining and is now being reshaped through reclamation efforts that combine natural regeneration with human intervention [Hinchcliffe, 2007]. This process has led to both environmental recovery and new economic opportunities through sustainable tourism, education, and recreational activities.

The successful transformation of Muskauer Faltenbogen from an industrial zone to a site of ecological and cultural importance demonstrates the potential for post-industrial landscapes to serve as spaces for environmental restoration and community



revitalization. This case highlights the interconnected relationships between geology, industrial history, and contemporary sustainable management efforts.

## 5. RESULT AND DISCUSSION

### Workshop Result

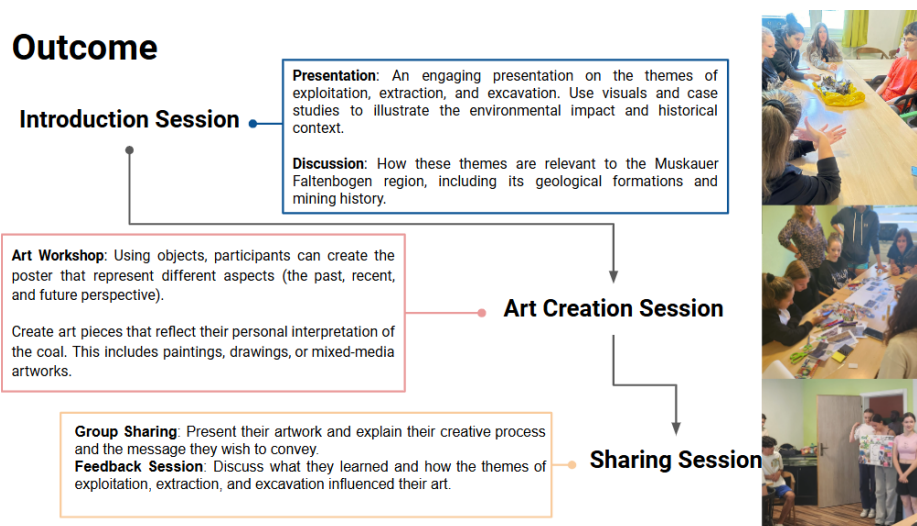


Fig. 1 The Outcome of the Workshop

### Youth Perspectives on Coal

The **Coal Diary** workshop engaged youth participants in creatively exploring the role of coal across different historical periods. Participants reflected on coal's transformation over millions of years and its contemporary use in industrial activities, highlighting its essential role in energy production and its contribution to environmental degradation. The youth demonstrated a nuanced understanding of coal, perceiving it as an energy source and a dynamic agent responsible for shaping landscapes through coal extraction, environmental damage, and subsequent recovery efforts. Their responses, particularly concerns about coal's finite nature and the need for renewable energy, reflected growing environmental consciousness among younger generations.

### Creative Outputs

The workshop encouraged participants to express their thoughts through collages and stories, visually representing coal and carbon's past, present, and future. These outputs portrayed the transformation of natural landscapes into industrial sites and the impact of coal mining on ecosystems and communities. A recurring theme in these creative projects was the contrast between the "Before" and "After" of coal mining, with the "Before" showing lush forests and healthy ecosystems and the "After" depicting degraded landscapes and polluted environments. In their future-oriented creations, youth emphasized the need to transition to sustainable energy sources, such as solar power, reflecting their hope for a world where carbon's destructive role is diminished.

### Ontographic Mapping of Coal

Ontographic mapping provided a framework to visualize and understand the relationships between coal, geological processes, and industrial activities, particularly in the context of Muskauer Faltenbogen. Through the workshop, the youth explored how carbon, in its form as coal, was a product of ancient glacial processes, peat bog formations, and lignite deposits. Their creative outputs further highlighted the connection between carbon extraction (coal mining) and ecological destruction. Additionally, the workshop reflected on post-industrial recovery efforts, including biodiversity projects, which aim to rehabilitate mining-scarred landscapes. This ontographic approach captured the complex web of interactions between human activities, carbon, and the landscape, demonstrating the dual role of carbon in both destruction and potential restoration.

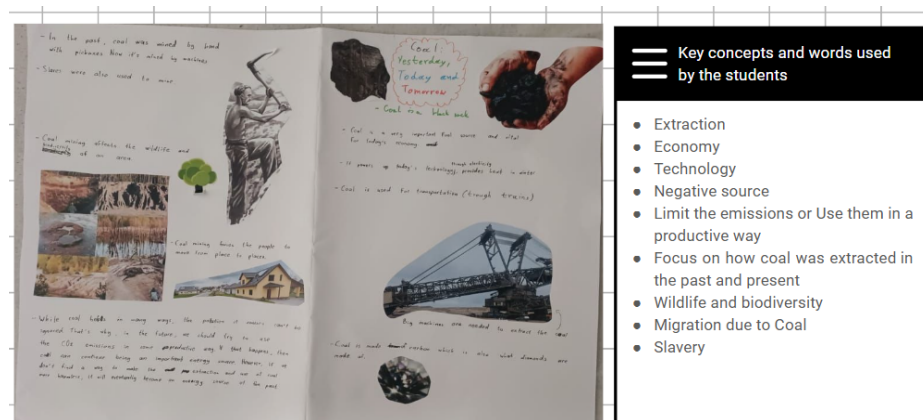
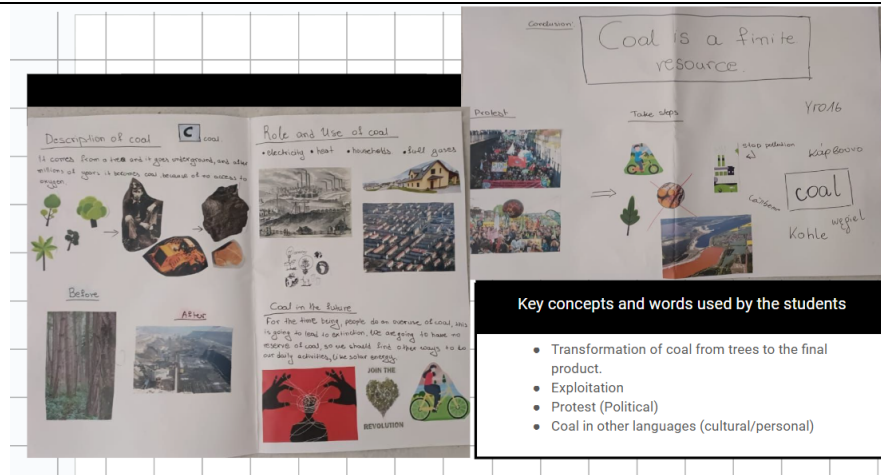


Fig. 2 "The Coal Diary" Result from 1st Group

The first team views coal primarily as **an active and dynamic resource**, consistently portraying it as a vital part of both the economy and global energy needs (See Fig. 2). They emphasize coal's role as a crucial fuel source, stating, **"It's a very important fuel source right now for the planet, a vital part of today's economy."** This perspective sees coal not merely as a material but as an agent of transformation. Rather than focusing on coal as a static object, the team describes it through action-oriented terms like "mining," "energy," "breaking apart," "pollution," and "provide," reinforcing its role as an active force in both natural and human processes.

A key quote, **"Coal mining forces people to move from place to place,"** captures the team's view of coal as a driver of social change, showing its capacity to displace people and alter communities. Coal is depicted as shaping landscapes and influencing human lives through the systems it powers. Even when mentioning that coal and diamonds are both made of carbon, coal is still framed as an active participant in broader processes rather than just a material. For this team, coal is an actor—constantly engaging with and transforming the world around it through its involvement in various systems of energy, movement, and industry.

Fig. 3 “The Coal Diary” Result from 2nd Group



The second team presents a more critical and subjective view of coal, focusing on its role in contributing to climate change and air pollution (See Fig. 3). While they still acknowledge coal's relationship to energy, they emphasize that coal is **not** a renewable energy source. This perspective introduces the idea that coal can, and perhaps **should**, be abandoned. The team articulates this stance clearly, stating: “We should move on and start using renewable energy: if we run out of it, we cannot use it anymore, so we should move on and start using renewable energy.” This highlights their belief that coal is a finite resource whose continued use is unsustainable.

The second team sees coal not so much as an integral part of current processes, but rather as an **autonomous entity** in its own right. This distinction leads them to advocate not for reforming how coal is extracted and utilized, but for replacing it altogether with renewable energy sources. Their approach suggests that the solution lies not in improving coal-based processes, but in fully transitioning away from coal to more sustainable alternatives. This outlook highlights the shift from coal dependency to renewable energy as a necessary step for addressing environmental concerns, framing coal as something to be left behind rather than adapted.

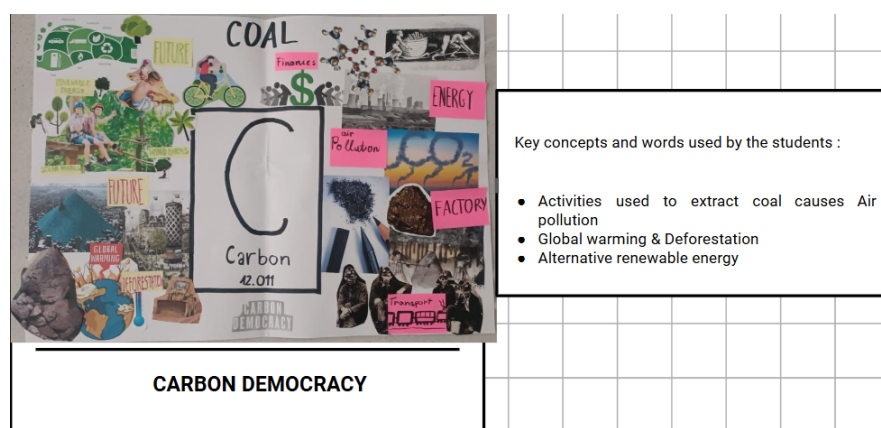


Fig. 4. “The Coal Diary” Result from 3rd Group

In the "Coal Diary" workshop, the 3rd group focused on the theme of "**Carbon Democracy**," exploring the environmental and societal impacts of coal usage (See Fig. 4). Their project highlighted key issues associated with coal extraction, particularly air pollution, global warming, and deforestation. Through a visual representation, they demonstrated how coal contributes to widespread air pollution

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and its role as a major contributor to carbon emissions, intensifying climate change and leading to the destruction of forests. Furthermore, the group emphasized the importance of transitioning towards alternative renewable energy sources as a solution to mitigate the environmental harm caused by coal. The workshop results reflect a clear understanding of the urgent need for sustainable energy practices to reduce the dependence on fossil fuels and address global environmental challenges.

The third command describes coal as a **changeable substance**, speaking of its different formations. It is the only team that mentions the historical and archaeological role of coal as a material that emerged “from trees over millions of years.” Next, we see the repeated narrative that coal is a resource: “And this is mining. The role and use of coal is electricity. In households, we use the energy, the heat, the water, and fuel gas”. And the thesis that coal must be phased out in the future: “And, in conclusion, we said that coal is a finite resource”.

## 5.2 DISCUSSION

### Carbon as a Co-Producer of Landscapes

The youth contributions in the Coal Diary workshop provided fresh perspectives on how carbon serves as a co-producer of landscapes, not merely as an inanimate resource but as an active force that shapes both ecological and human environments. Their representations of coal mining’s impact emphasized how landscapes have been altered—both geologically and socially—by the extraction and use of carbon-based resources. This understanding reshapes the narrative of coal, positioning it as a dynamic agent of landscape transformation, deeply intertwined with industrialization and ecological degradation.

### Integration of Human and Non-Human Perspectives

Ontography, by its nature, breaks down the traditional distinctions between human and non-human actors. In this study, the ontographic mapping of carbon highlights the interconnection between geological processes (such as the formation of coal), human industrial activities (coal mining), and post-industrial recovery efforts. The creative outputs from the workshop reflect this integration, showing how carbon moves through different forms and processes—crossing boundaries between the biological, geological, and human-made environments. This perspective enables a more comprehensive view of landscape transformation, in which human actions (such as mining) and non-human processes (such as coal’s role in the carbon cycle) are seen as part of a broader, interconnected system.

### Impact of Youth Engagement

The participatory methods used in the Coal Diary workshop allowed for active engagement from the youth, contributing to new narratives around carbon and environmental restoration. By involving youth in discussions about coal mining and carbon’s role in shaping landscapes, the workshop empowered them to voice their concerns and ideas for the future. Their focus on renewable energy and ecological recovery suggests a growing awareness and commitment to environmental

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sustainability. Moreover, their creative expressions provided a platform to reimagine the future, challenging the current reliance on coal and advocating for sustainable alternatives. This engagement also emphasizes the importance of including younger generations in environmental discourse, as they are likely to drive future change.

### **Challenges and Limitations**

While the Coal Diary workshop provided valuable insights, several challenges and limitations must be acknowledged. First, the scope of participant involvement was relatively narrow, which may have limited the diversity of perspectives represented. The workshop primarily included a small, specific demographic (teenagers), which may not fully capture broader societal views on carbon and coal mining. Additionally, the creative outputs, while rich in qualitative data, presented challenges in terms of quantifiable analysis. This limitation underscores the need for further research involving a larger and more diverse group of participants, as well as the inclusion of other methods to complement the qualitative findings derived from creative activities.

### **Further Activities to educate/engage Youth in exploring the “Just transition” of Coal landscapes**

- Interactive models of coal power plants

Coal impacts the environment in multiple ways, though students often believe the smoke from power plants is the most harmful. While it's a significant source of carbon dioxide, it's not the only environmental concern. By using an interactive model of a coal-fired power plant, students can explore the various components of the facility and understand how each part contributes to environmental effects. This visualization helps them grasp the broader environmental impact of coal power.

- Games and activities

Games and interactive activities not only make learning more engaging but can also improve its effectiveness. In fact, they can sometimes be more impactful than conventional lectures. For example, Labster's virtual lab simulation, *Environmental Impact of Coal Power Plants*, serves as a great educational tool. It lets students explore how coal power plants affect the environment while actively involving them in developing solutions to these environmental issues. This hands-on method encourages deeper understanding and critical thinking skills.

- Connecting coal to the applications in real world

Linking the subject of coal to real-world examples and students' daily lives helps them better understand its impacts. For example, explaining how coal pollution can lead to health issues such as asthma and heart disease makes the consequences more relatable. Additionally, highlighting how coal mining affects wildlife and damages ecosystems further illustrates its broader environmental impact.

- Cultural preservation, Storytelling and Artistic expression



Engage youth in preserving and reinterpreting the cultural significance of coal regions. This can include working on heritage projects, creating art, or developing media that explore the socio-cultural history of coal, while also emphasizing a future aligned with sustainability. Support youth-driven initiatives in storytelling, filmmaking, music, or other forms of artistic expression to convey the cultural shift from coal. Artistic expressions can play a powerful role in shaping public opinion.

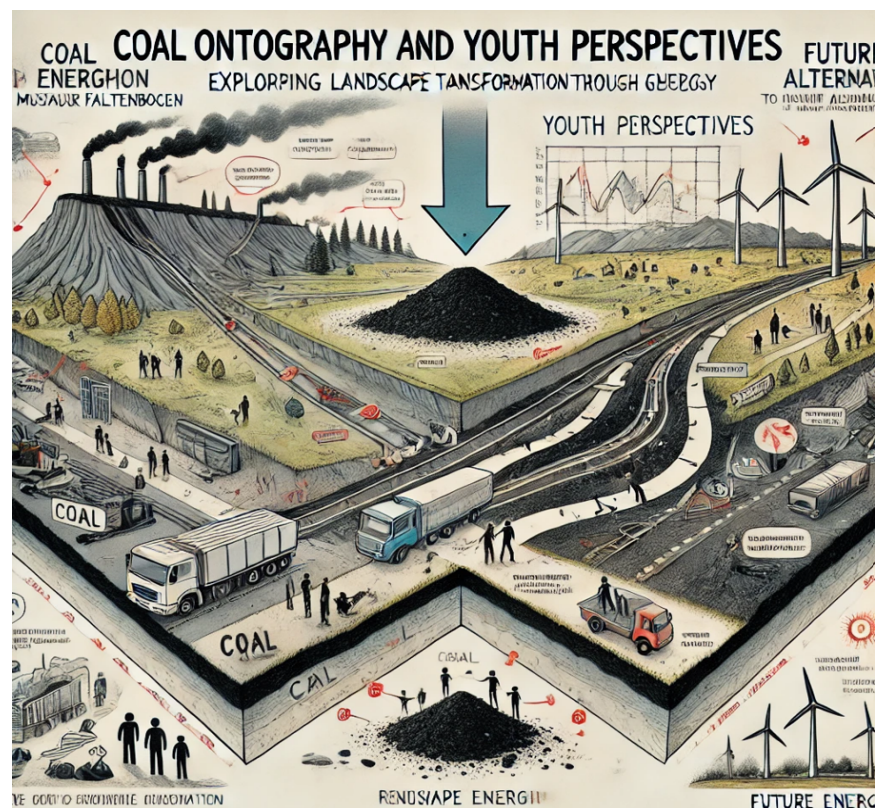
- Careers in the coal industry

One approach to engage students in exploring coal-related topics is by introducing them to career opportunities in renewable energy, conservation, and sustainability. This can motivate them to deepen their understanding of the subject and encourage proactive involvement. By designing a curriculum focused on training students, the goal would be to transition lost mining jobs into new, sustainable forms of employment that protect the environment.

- Involvement in Policy Design

Include young people in working groups and task forces that focus on drafting policies for energy transitions, coal phase-outs, and economic diversification in coal-reliant regions. This ensures that youth perspectives are integrated into the earliest stages of policy development.

## 6. CONCLUSION



The case study of Muskauer Faltenbogen, highlights the landscape transformation in the Lusatia region, primarily driven by coal extraction activities. Coal mining has

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compromised the landscape's ability to meet societal needs, while also generating new meanings and influencing local perceptions of environmental risks. As the region recovers, with society now engaging in ecotourism and conservation, this mutual interaction fosters a shift in values towards sustainable land use, highlighting the role of education in this transformation.

A vital aspect of the landscape's transformation is the shift from viewing Muskauer Faltenbogen as a resource for extraction to recognizing it as a landscape worthy of preservation. Society's changing ontology of coal—from a critical resource to a symbol of environmental degradation—has altered how people relate to this landscape, driving efforts to preserve it as a geopark and a site for tourism and education rather than continued extraction.

The study adopts an ontographic approach, showing that coal's influence extends beyond being a mere resource; it actively transforms both the physical environment and human history. The 'Coal Diary' workshop, which incorporated youth perspectives, illustrates that younger generations are not only aware of coal mining's legacy but are also committed to shaping sustainable futures. The study underscores the intricate ways coal influences both geological and human landscapes, with landscapes themselves playing a role in shaping societal values. By blending ontographic methods with youth-centered, participatory approaches, the research emphasizes the need to address coal mining's environmental legacies and promote long-term ecological stewardship.

Fig. 5 The Summary of “Coal Diary Workshop” Result (AI Illustration, 2024)

The workshop with young adults revealed that participants primarily perceive coal through its processes and actions—such as mining, transportation, and conversion into energy—viewing it as a dynamic and transformative element rather than a static material. The emphasis is on coal's role as a resource in various stages of transformation rather than on the coal itself. Nevertheless, two out of three teams acknowledged coal as a finite, independent object. Notably, only one team addressed the initial formation of coal from wood, while the others focused solely on its subsequent transformation into energy.

Furthermore, two of the three groups foresee a future without coal, highlighting its detrimental effects and associated problems, which contribute to a negative perception of the material. This perspective suggests a hypothesis that adverse environmental impacts may shape coal's image as a harmful conventional resource. In contrast, the third group maintains a more balanced view, recognizing the inherent value of coal and proposing changes to the processes involving coal rather than condemning the material itself.

These findings indicate that coal's perception is significantly influenced by the context of its use—either positively or negatively. Therefore, future efforts to alter perceptions should also include initiatives aimed at promoting coal's intrinsic value as a material, rather than solely focusing on its role in energy production.

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## Appendix.



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## 1. Text of the teams' speeches

### Team 1

In general, about coal, we thought in general about coal and its use, what we think can be used for and will be used for in the future. Coal isn't black rock, okay? It's a very important fuel source right now for the planet, a vital part of today's economy. It provides work and it has many benefits for the economy. It's also used for a lot of today's technology and electricity; it provides also heat. And in transportation, it's a fuel source for transportation, especially trains, which call to fuel, for fuel. For the extraction, right now, like today, I do big machines, like this one here. And a fun fact is that it's made of carbon, as well as diamonds are made from carbon.

So, this is some general information about Coal. Now, let's go into its history and what it will be like in the future, or what we hope, so, what we dream of. So, in the past, coal used to be mined by hand, using pickaxes. And, to be fair, mostly slaves were used in order to mine Coal, since people didn't want to risk their lives going to the Coal mines and risk getting diseases or things like that. Coal mining, it is true that it affects the environment, it affects the wildlife and the livelihood of the area. It can have many harmful effects on the area the Coal mines are in, and on the areas the industries are in. Yeah, Coal mining forces people to move from place to place. Since if an industry opens up, like, one kilometer away from our house, we can't stay in the area, probably, because it will be a very unhealthy atmosphere to live in, and you will probably catch some diseases.

Now, how will coal be in the future? While coal helps in many ways, the pollution from it can be reduced. So, I think that in order for coal to remain an energy source and not stay as an energy source of the past, or that's how we will call it in the future, we should try to find ways to make the carbon dioxide emissions healthy. Since energy is provided to us by breaking apart the coal, we could try to get the ingredients back together again, or just try to limit or reduce the emissions of carbon dioxide. So, not only will we be able to limit the pollution of the environment and mostly the atmosphere, but we will also find a way to make coal an even more important energy source than it is now. Thank you.

### Team 2

Coal is in transport, causes such disadvantages as climate change and air pollution, so in the future we have global warming, deforestation, and to fight that, to avoid that, we can use wind farms, solar panels, and renewable energy to avoid our planet from environmental degradation. So coal, as we know, is not renewable energy, it's just be itself, and if we run out of it, we cannot use it anymore, so we should move on and start using renewable energy.

### Team 3

We begin with a description of the coal, which comes from the tree before millions of years. It goes underground and after millions of years it becomes coal. This is the picture. This is before. And through the mining, we can find coal here. Before, it was a tree. And this is mining. The role and use of coal is electricity. In households, we use the energy, the heat, the water, and fuel gasses. Okay, what do we think about coal in the future?

People do an overuse of everything, so does coal. So, coal is going to fix things. So, we have to find other ways to do our activities, as we said before. And, for conclusion, we said that coal is a finite resource, so we have to protest. And to take steps and find other ways to do our activities without coal. And we wrote coal in our five languages. Greek, Romanian, Polish, German, and Ukrainian.

## 2. Work Summary

Work Summary	Details
<b>1. Initial Phase:</b>	<ul style="list-style-type: none"> <li>- Discussion of theoretical direction (all)</li> <li>- Proposal of workshop concept (Polina)</li> <li>- Drafting (all)</li> <li>- Introduction (Polina)</li> <li>- Argument (Peilin)</li> <li>- Geopark (Viny)</li> <li>- Conclusion (all)</li> </ul>
<b>2. Workshop:</b>	<ul style="list-style-type: none"> <li>- Discussion on the design and arrangement of the workshop (all)</li> <li>- Leading activities (Viny, Peilin, Adarsha)</li> <li>- Preparing the materials (Peilin, Adarsha)</li> <li>- Groups speech script (Peilin)</li> <li>- Documentation of activities (Viny, Peilin)</li> <li>- Finalization and information gathering (Viny, Peilin, Adarsha)</li> <li>- Ideas for future exhibition (Polina)</li> </ul>
<b>3. Presentation:</b>	<ul style="list-style-type: none"> <li>- Presentation of the overall concept (Peilin, Adarsha)</li> <li>- Report refinement and formatting (Viny)</li> <li>- Introduction and theory (Peilin)</li> <li>- Geopark and workshop (Viny)</li> <li>- Analysis of workshop results (Viny, Adarsha)</li> <li>- Conclusion (Polina)</li> <li>- Ideas for future exhibition (Polina, Peilin)</li> </ul>
<b>4. Written Report:</b>	<ul style="list-style-type: none"> <li>- Discussion on writing style and overall concept (all)</li> <li>- Confirmation of research questions (all)</li> <li>- Report refinement and formatting (Peilin, Viny)</li> <li>- Introduction (Viny, Polina)</li> <li>- Theory and workshop methods (Peilin, Polina)</li> <li>- Geopark and workshop analysis (Viny)</li> <li>- Results analysis (Polina, Viny)</li> <li>- Groups speech script (Polina)</li> <li>- Conclusion (Viny, Adarsha, Polina)</li> <li>- Ideas for future exhibition (Polina)</li> </ul>

Table 1. Work Summary and Division of Tasks

## 3. Exhibition Ideas

Based on our research, we see an opportunity to create an exhibition that will be a point of intersection between information about what coal is and an opportunity for visitors to reflect on their perceptions of coal. As we see from the student workshop, coal can have a negative image due to the fact that coal mining processes can have negative environmental consequences. However, the material itself has a number of values that are lost and not obvious, especially to the younger generation - for example, coal is also an important source of the history of the earth, an example of how society has changed from industrial to post-industrial and other important themes where coal can become a storyteller and protagonist. In this way, the exhibition should become a space of new acquaintance with coal and its rethinking.

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# Exhibition ideas

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- 1

Talk about what coal is and show the variety of its forms
- 2

Show the result of the workshop as an example of reflection on the role and value of coal
- 3

Creating a space that invites visitors to share their thoughts on what coal is all about

Fig. 6 The Exhibition Ideas





