Field School on Post-Mining Territories: Interdisciplinary Approaches in Morocco's Mining Towns in Transition

Field School on Mining Towns in Transition - Morocco, 2025
Field Journal

May 23 - May 29, 2025.

Sandra McKay (PhD Candidate), Hassan Dahmouni (PhD Candidate), Dr. Latifa Rouzi, and Dr. Imad Eddine Cheddad

Introduction

This journal reflects the activities, discussions and reflections from the field school to Morocco's oriental mining towns between May 23 and May 29, 2025. This field school is part of LIA SESAM and the MinErAL Network. The SESAM International Associated Laboratory is a joint initiative of the INQ Research Chair on Northern Sustainable Development at Laval University (Quebec) and the Plant Biotechnology and Physiology Laboratory at Mohammed V University (Rabat). SESAM aims to be a global reference in the field of mining site transition. The MinErAL Knowledge Network on Mining Encounters and Indigenous Sustainable Livelihoods brings together scholars, partners and researchers who focus on encounters between Indigenous communities and mining.

This journal was elaborated in collaboration between the "researchers" of the field school. This is to reflect the collaborative, interdisciplinary and multilingual nature of this school. These include Sandra McKay (PhD student), Hassan Dahmouni (PhD student), Dr. Latifa Rouzi, and Dr. Imad Eddine Cheddad.

The field school team included, as Professors from Canadian universities, Pr. Thierry Rodon (Political Science), Pr. Sophie Theriault (Dean of Law), and Pr. Tiff-Annie Kenny (Health Science). It also included Professors from University Mohammed V (Rabat), Pr. Mouna Fahr (Biology) , and Pr. Aziz Smouni (Biology), and Dr. Clement Levard (Geochemist), Research Director at the National Center for Scientific Research (CNRS) and the Institute for Research for Development (IRD).

The 7-day field school started with a seminar at Mohammed V University in Rabat. We then visited three "post" mining towns in different parts of East Morocco - Mibladen, Ahouli, and Jerada. The field school concluded with a visit to the Mohammed V University in Oujda. We say "post" mining, because mining remains active, although in a different way, in the three towns we visited. For instance, mining remains "alive" infrastructurally, through mining museums (for mineralogy, photography, and archives), abandoned equipment, and ruins of what appear to be "ghost towns".

It also remains alive environmentally, with massive mine waste sites that appeared to have blended into the landscape as new hills. And lastly, mining remains alive through "informal" and artisanal miners, who have continued to extract the leftover minerals in the "post" mining towns in attempts to extend, albeit in a limited way, some of the financial benefits that mining could bring to local peoples.

The team that participated in these visits has expertise in different aspects of mining. This interdisciplinarity allowed for enriching group discussions. Sandra is a PhD student in Global Development Studies at Queen's University (Kingston, Canada), where she specializes in Artisanal and Small-Scale Mining formalization in Peru. Latifa Rouzi holds a PhD from the Scientific Institute Mohammed 5 University of Rabat (Morocco), in Toxicology and Public Health speciality. She is an expert in epidemiology, particularly the effects of lead exposure on public health. Imad holds a PhD from the Institut National d'Aménagement et d'Urbanisme (Rabat, Morocco). His doctoral research focused primarily on the political management of phosphate-oriented mining cities. He is currently working on recoversion in post-mining territories, specifically Midelt and Jerada, through the valorization of tangible and intangible heritage. Dahmouni Hassan is a PhD student, and a geologist trained in georesources and mining waste recovery.

Our discussions were in different languages, too, speaking in a combination between Spanish, French, English, Arabic and Tamazight, reflecting the truly international characteristic of this team. Because we come from various backgrounds, we identified different key main lessons learned in this field school. These are initial impressions, as more extensive research is needed to confirm these impressions.

First, **Hassan** shared that this doctoral school highlighted the importance of understanding post-mining issues and industrial heritage as key elements in planning the reconversion and sustainable development of these areas. The discussions during this school, and in the field visits, covered health, heritage, ecological, biological, geological and social issues, with valuable contributions from environmental health and indigenous studies, particularly from Morocco, Canada, and Peru. This diversity of viewpoints enabled a better understanding of the challenges associated with these territories, integrating environmental aspects, local communities and informal activities.

Second, **Latifa** shared that this doctoral school has allowed us to gain a deeper understanding of the situation of informal miners, shedding light on the unfavorable conditions in which they work. Particular emphasis was placed on the lack of protective measures, which leads to direct exposure to various risks. Moreover, activities such as cooking meals within the mining sites further increase these hazards. It is important to note that behind these informal miners are often entire families, including women, children, and the elderly who are also likely to be exposed to different chemical pollutants.

Third, according to **Sandra**, our visits suggest that one contributor to the expansion of artisanal and informal mining appears to be the absence of an adequate mine closure plan that would have included economic reconversion of the mining town. This is a contributor that has not been

sufficiently included in the international literature on artisanal and small-scale mining, and further inclusion of "post-mining ASM" in the academic literature would be timely. The three case studies we visited in Morocco were "post" mining towns where locals and people from the surrounding towns started informal mining, due to an absence of alternative economic activities once industrial mining shut down. This is despite the harsh working conditions that these miners experience, and the low or inconsistent income that this activity generates for them. Coming from Peru, learning about this similarity between a case study in Peruvian artisanal mining was valuable, as they, too, operate informally in the abandoned galleries left by an old industrial mine due to a lack of economic alternatives; the miners she interviewed in Peru even recall that the start of their informal mining operations started when the industrial mine left, and their town became "a ghost town", that was revived by artisanal mining. Learning about the Moroccan artisanal mining helped her gain a better insight on Peruvian artisanal mining, as the issues they experience are not isolated, but seem to be part of a larger, international trend.

Lastly, for **Imad**, it was both a scientific and a human experience. On the one hand, it forms part of his postdoctoral trajectory by broadening his empirical field of investigation, particularly in relation to Moroccan mining territories. On the other hand, this field school provided him with an opportunity to explore other disciplinary perspectives and international case studies of mining territories. In this regard, the transdisciplinary and interdisciplinary approach remains essential for understanding the complexity of these territories, which are often reduced to their industrial function in the narrow technical sense of the term. While the application of such an approach continues to face multidimensional constraints, it nonetheless enables, in our case, the articulation of elements that would remain inconceivable within a binary framework—for instance, questioning the relationship between a plant species and the local political order of a mining territory. Lastly, the cultural factor plays a prominent role in the overall analysis of mining territories in the region of Midelt, extending from Ahouli and Mibladen to Jerada. This dimension was equally significant in shaping the overall atmosphere of the research group that formed this doctoral school, as it was grounded in intercultural and multilingual exchange.

As researchers in this field doctoral school, we are deeply grateful to the organizers and those who welcomed us throughout our journey. We would like to thank all the Canadian and Moroccan organizers, as well as the communities of Mibladen and Ahouli, for their hospitality. We would also like to thank the authorities of Midelt and Jerada for their support and kindness. We are grateful to all the organizations that provided financial support (the Québec-Kingdom of Morocco Call for Projects led by the MRIF, SSHRC Mineral, LMI AMIR, LIA SESAM), allowing this doctoral school to be organized and successfully completed.

Day 1 - Seminar at University Mohammed V - Rabat
May 23, 2025

The doctoral school was officially launched as part of the SESAM 2025 seminar, held at the Faculty of Sciences of Mohammed V University in Rabat. This initiative is part of the SESAM project, a collaboration between the INQ Research Chair on Sustainable Development in the North, Faculty of Social Sciences, Université Laval (Canada) and the Laboratoire de Biotechnologie et Physiologie

Végétales, Université Mohammed V, Rabat (Morocco). The project aims to develop interdisciplinary and international thinking on issues related to mining areas. It fosters exchanges of experience and knowledge sharing by mobilizing complementary expertise in the natural sciences (Mohammed V University), social and health sciences and law (Quebec universities), with the aim of designing transdisciplinary research projects.

Seminar at the Rabat Faculty of Science, May 23, 2025.

Session 1: Socio-economic, health and heritage characterization of the Mibladen and Ahouli mining sites

During this session, **Prof. Thierry Rodon**, Professor of Political science at Laval University and co-director of LIA SESAM, presented the results of a socio-economic characterization survey of informal miners in Mibladen, Ahouli and Ksar Ahouli. His presentation highlighted the socio-economic and environmental impacts of abandoned mining activities in these regions. In particular, informal artisanal mining is the main source of income for many of these miners. For her part, **Prof. Tiff-Annie Kenny**, Assistant Professor at University of Montreal, gave a presentation on the health characterization of informal miners in Mibladen and Ahouli. Her analysis showed that women suffer more frequently from neurological, digestive and cardiovascular disorders, while men suffer more from kidney disease, skin problems and muscular pain.

Mr. Hassan Dahmouni, PhD student at Ecole Nationale Supérieure des Mines de Rabat (Rabat School of Mines), presented his work on participatory post-mining reconversion in Mibladen and Ahouli (Morocco). This was based on a cross-analysis of perceptions and alternatives gathered during focus groups, using the results of a survey carried out in 2023. Discussions with informal miners, both men
and women, from Mibladen, Ahouli, and Ksar Ahouli identified several concrete avenues for territorial reconversion: the creation of multi-service women's cooperatives, the development of agriculture for former miners, the promotion of tourism of mining heritage, and the promotion of regulated artisanal mining.

Dr. Imad Eddine Cheddad, postdoctoral researcher affiliated with the LIA SESAM, currently working under the supervision of Professor Thierry Rodon, presented on the characterization of tangible and intangible heritage with mining and industrial value, as well as the prospects for developing tourism in the sites of Ahouli and Mibladen, in close connection with the potential of Midelt, the provincial capital. He emphasized that the old mines represent a major industrial heritage, bearing witness to the region's economic and social history. However, this heritage still remains underdeveloped, despite its great potential for tourism and economic conversion projects.

Session 2: Phytoremediation and environmental characterization of mining sites

The second session was focused on plant biology, specifically on phytoremediation strategies applicable to former mining sites. **Prof. Mouna Fahr** presented the results of an environmental characterization of the Midelt region, with particular emphasis on the Zaida and Mibladen sites. Mr. **Alassane Diallo,** PhD student at the Faculty of Science at University Mohammed V , spoke on native plants screening for assisted phytoremediation: evaluating species potential and soil amendments for enhanced metal tolerance and growth on abandoned Pb/Zn mine sites in Morocco, focusing on the screening of native plant species and the evaluation of soil amendment effectiveness for enhanced metal tolerance and plant growth on former lead and zinc mine sites in Morocco.

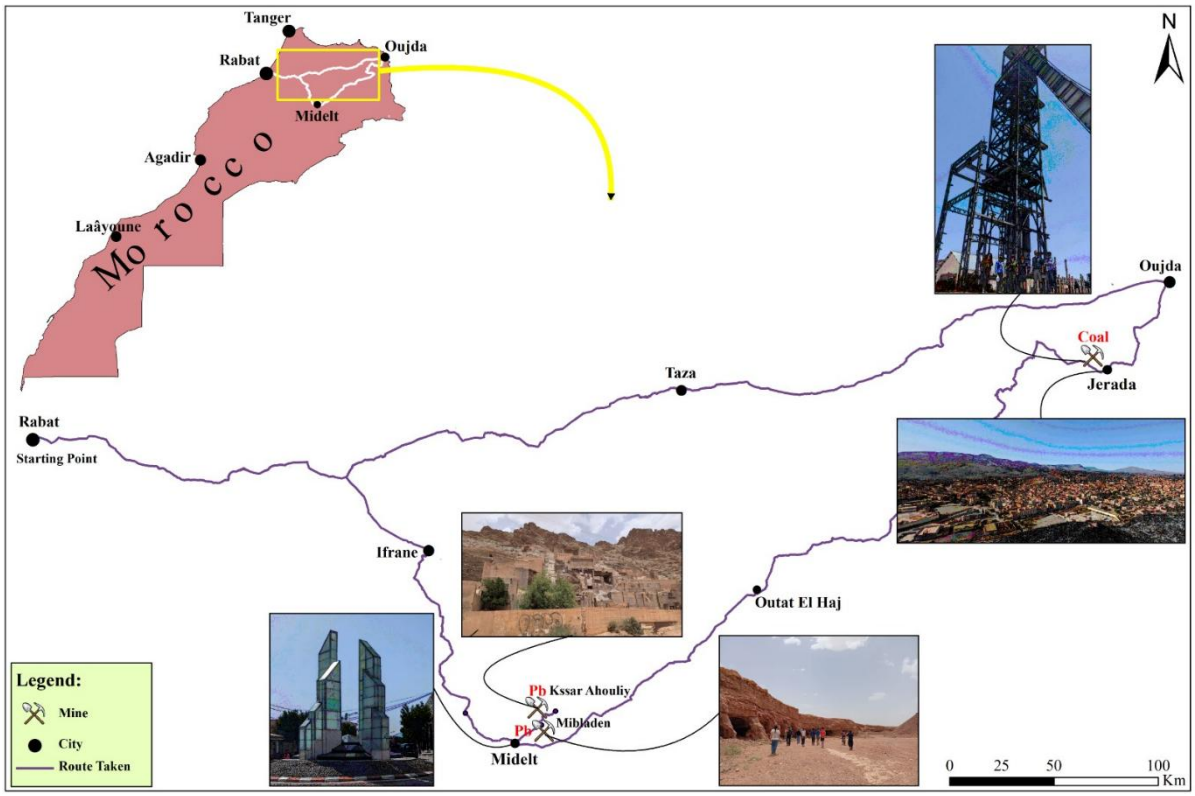
Oumaima El Khattabi, PhD student at University Mohammed V, gave a presentation entitled “Improving lead tolerance and accumulation in plants: perspectives for the development of phytoremediation strategies”, in which she discussed approaches to improving lead tolerance and accumulation in plants, opening up promising prospects for the development of suitable phytoremediation strategies.

Session 3: Health impacts, mining policies and environmental justice

The afternoon was devoted to presentations dealing with health issues, mining policies and environmental justice. **Dr. Latifa Rouzi** presented a study on non-occupational lead exposure among mother-newborn pairs and lead exposure’s effects on maternal and fetal health in Casablanca, Morocco. This research revealed alarmingly high levels of lead in 65% of the cases. These elevated lead levels were particularly observed in mothers with multiple obstetric complications, such as miscarriages, preterm births, stillbirths, and low birth weights.

Additionally, several risk factors were associated with higher lead concentrations in the cord blood, including: the use of traditional clay pots ("Tagines") for cooking, storing food in artisanal clay jars,living in urban areas and near to industrial sites, and home renovations. **Sandra McKay,** Phd student at Queen's University, then presented a paper entitled "Expanding the critical mining frontiers: the (In)Formalization of artisanal and small-scale copper mining in Peru". Her presentation focused on Peru's artisanal and small-scale mining sector, including the social, economic, and legal issues that arise from policy gaps in government-led formalization policies. **Professor Sophie Thériault** (Dean of the Faculty of Law, University of Ottawa) spoke on the theme of justice and the energy transition: government policies, indigenous communities of Canada, and the expansion of the use of the energy transition in mining projects.

Day 2 - Departure from Rabat to Midelt
May 24, 2025



Travel routes and visited sites during the summer school program

Today we drove from Rabat to Midelt in a caravan of two cars. As shown on the map (Figure 1), the route starts in Rabat and covers almost 340 km, passing through Ifrane, a town in the Middle Atlas Mountains, where we stopped before continuing on to Midelt. In the car ride, we reflected on the benefits and challenges of conducting comparative research between different mining regions, and the characteristics of the concession granting processes in different countries.

We arrived at Midelt in the evening. Over dinner, the group of researchers discussed the importance of South-South collaboration between Morocco and South America, including Peru.

Day 3 - Midelt mining: Mibladen
May 25, 2025

These two first days of visits were to “post” mining sites in Midelt, including Mibladen (May 25) and Ahouliy (May 26).

Midelt is a province situated administratively in the Draa-Tafilalet region, where Morocco's Middle Atlas and Eastern High Atlas ranges meet. It nestles at the foot of Jbel Ayachi at an altitude of 1521m in the upper Moulouya basin. It is characterized by a semi-arid climate, with hot fields and cold winters. As explained by Dahmouni, Midelt's economic assets are largely based on its natural resources; the province has considerable potential in terms of renewable energy (wind and solar). Midelt is also renowned for its fruit production, particularly apples, a local pride, for which they have different monuments across the province. The region has also long been known for its mining wealth, which was exploited until the 1980s. The Mibladen and Ahouliy mines, located 15 km and 25 km northeast of Midelt, respectively, were mainly Moroccan lead extraction deposits. Today, these mines have been abandoned, and the mining activity has left behind a number of dizzying features, including, among other visible features, galleries, ruins of mining installations, and abandoned buildings.

Route taken during this doctoral school

In the morning, we first stopped to see a monument of crystals in the center of Midelt. This monument shows the city's recognition of the importance of the artisanal extraction of crystals, including vanadinite. Sandra shared her confusion over the legality of this artisanal mining activity, as they are not formalized by the government (unlike artisanal coal mining in Jerada), but they are “tolerated” by the local authorities and the current concession holder.

Monument to crystals in Midelt’s city center.

We headed towards Mibladen. In Mibladen, we visited sites that had two distinct types of artisanal mining: first, for crystals and then, for lead. The crystals are extracted artisanally through vertical holes in different locations, whereas the lead is extracted following horizontal veins in a single hill with several wide galleries. When we were visiting the outside of the artisanal crystal mines, a man approached us with minerals for purchase.

Artisanal informal mine in Mibladen.

Local mineral seller

Imad, who guided us to the industrial heritage in Mibladen and Ahouli, shared that the site of Mibladen is rich in both tangible and intangible heritage that could be leveraged for tourism such as mining tourism, community-based tourism, and scientific tourism as well as for artistic purposes like film making. The area is also characterized by scattered initiatives aimed at establishing mining museums, reflecting its potential for heritage preservation and promotion.

Imad noted that this doctoral school team focused on the rich potential of Mibladen, which eagerly awaits support from economic diversification initiatives, including an initiative to promote a women's handicraft cooperative. A territorial marketing effort and networking through the decentralized cooperative (twining) could help structure concrete actions for (re)development of the local economy.

To illustrate just one of the several locations that could be appreciated for tourism, when we were on site, Dahmouni, a trained geologist, took us to visit limestone rock slabs at the entrance of the area, which contain extremely rare fossilized footprints of dinosaurs, as explained by dahmouni. These remains represent a remarkable geological heritage of the Midelt region.

The local vegetation around these outcrops is dominated by a medicinal plant called *Peganum harmala* and *Artemisia herba-alba* .

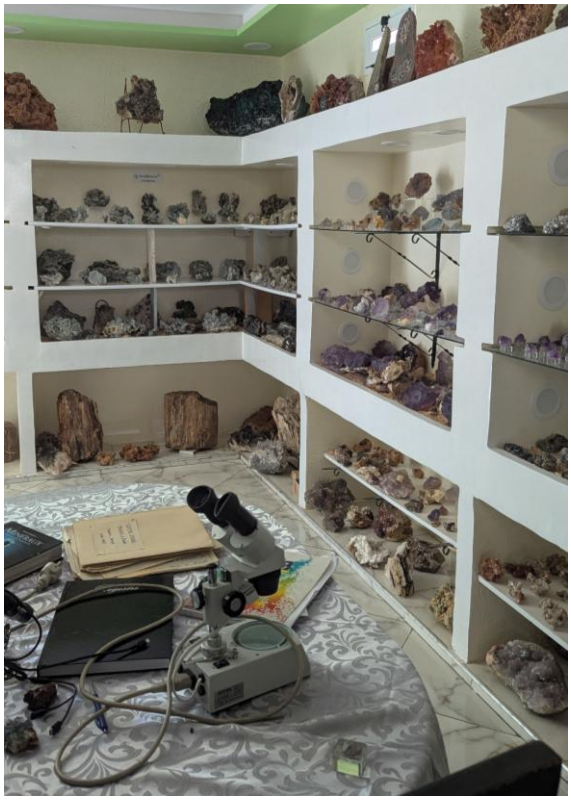
We then continued driving to the Mibladen "post" mining site. As we neared the site, we drove by women and children who were selling precious rocks on the road. Sandra noted this peculiarity in the trading of high-value minerals from informal artisanal mining, as this might indicate a specific type of dynamics in the supply-chain system, influenced by the geological materiality of the mineral extracted. In this case, it seems like individual buyers visit the mine town to purchase the rocks at a very small scale, instead of miners pooling their products and transporting it in large quantities to centralized markets or processing centers. In her experience studying supply-chains in informal mining in Peru, she has seen that this specific configuration has been associated with lower financial earnings by the miners, as under this configuration, the miners do not determine the price of the mineral based on the international commodity price, but on the value determined by the visitor-buyer.

In Mibladen, we visited a small museum dedicated to workers' and community memory. This is distinct from a traditional institutional or national museum. This small museum is a personal initiative, led by a general practitioner from Mibladen who preserves a collection of photographs retracing the history of this mining village since its founding by showcasing selected archival materials from the mining company and key events that shaped the village. This initiative of a museum was remarkable. A significant effort has been made to collect old photographs related to the collective memory of Mibladen, documenting the trajectory and evolution of the entire village.

In 5 small rooms, the museum kept the memory of the mining history of Mibladen alive, including walls filled with photos of the miners, the engineers, the mining operations, and health campaigns. It also included a library with books retelling the history of the town in French and Arabic, as well as some original documents.

Mibladen preservation of photographs and books retracing the mining history of the mines

After visiting the museum, we went to two small, privately-owned and managed mineral "museums" that had rock collections from the minerals mined in the area. These included both rocks for display and several rocks in smaller sizes for purchase. Dahmouni explained that Morocco is often referred to as a "geologist's paradise" due to its exceptional geological and mineralogical wealth. Mibladen, in particular, is internationally recognized as a world-class site for vanadinite, including the famous lead chlorovanadate crystals, as well as for a wide variety of other minerals.



Visits to two small mineral museums , Mibladen. The picture below is at the Abderrahmane Museum, passionate about mineralogy in Morocco, particularly in Mibladen and its surrounding areas.

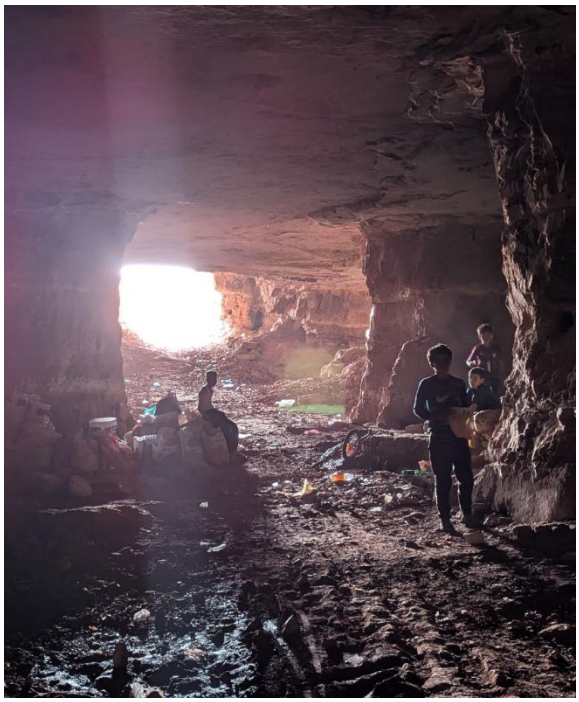
Afterwards, we wandered through the town, stopping at several buildings abandoned by the former mining company. We visited the former administration building of the Mibladen and Ahouli mining company, and the swimming pool in front of it. The tour also included a visit to the managers' and engineers' housing estate, as well as the Mibladen workers' housing estate.

Buildings abandoned by the mining company in Mibladen

Then, we entered the lead mines. These mines were easy to find, quite open, and easy to access. As the picture below shows, we simply walked into the mines.

Walking directly to the artisanal mines in Mibladen.

As we walked and explored the mines, a group of children followed us inside. Sandra remarked how strange it was to see children entering mines, something that is typically denounced as a major problem in artisanal and small-scale mining globally. However, in this circumstance, it looked more like curious children following a group of outsiders.



Group of curious children inside the mine.

As we walked inside the mines, Dahmouni took us into the galleries, explaining and showing the carbonate layers composed of limestone and dolomite from the Middle Lias. He explained that the mineralization in this location was of the Mississippi Valley-Type (MVT), which takes the form of subhorizontal clusters hosted in two Lias carbonate series. The ore, with economically exploitable lead grades, consists mainly of galena and cerussite, embedded in a gangue of dolomitic limestone and barite. Dahmouni explained that the drifts in this mine are because the ore layer is horizontal, and therefore the mining method for mining companies is what is called the chamber and pillar method. This helps explain the physical structure of the mine - as having several wide open galleries on a single level. The site is also distinguished by the diversity of its minerals, including vanadinite, wulfenite, barite, galena, cerussite, anglesite and others.

Dahmouni Hassan explaining to the team (and to a group of curious children) the chamber and pillar method in this mine

We learned that the rock in this mine is sufficiently solid to ensure the stability of the galleries, thus reducing the risk of collapse. In addition, the mine appears to have only one level, which further limits potential dangers to the workers - and to us, as visitors. During our visit, the team met an artisanal miner living in Mibladen. He was working in a shaft in search of galena, locally known as l'*Kahal*. He was very friendly and exchanged a few words with us before offering us a cup of tea. He told us that even if the lead was of lesser quality than in Ahouli, he would rather work here since there were less risks in this mine. He also stresses that this informal mining, even if it is a difficult job, give him the freedom of having no fixed schedule and no boss telling him what to do.

He then kindly offered to guide us further inside the galleries, towards a secondary exit, to help us discover the mines without getting lost. Although the galleries are spacious, well-ventilated and relatively safe, it is worth noting that none of the visitors or workers present were wearing any personal protective equipment (PPE).

Furthermore, while visiting the mine, Latifa noticed that the miners have cooking equipment to prepare tea and other quick meals inside the mines, which increases the risk of ingesting mining particles and aggravates the exposure of informal workers to harmful particles.

Conversation with the artisanal miner in Mibladen, and a shared cup of Moroccan tea inside the mines.

Picture of Vanadinite in Mibladen, extracted by artisanal miners

Next, we went to a track to observe mine waste, tailings, or washing sands, left over by the former industrial mining activities. On our way there, we passed by more buildings abandoned by this old mining company. As we were walking by, we also passed by a family working below the tree in the picture below, they were digging on the ground, mining for scrap metal as a source of income.

Ruins of the former lead processing plant in Mibladen.

Dahmouni explained that the mine residues that we visited here are deposited on the slopes near the water stream. These come from the processing of lead ore by the old mining company. They underwent various processes: crushing, grinding and flotation. After the mining operations ceased, these tailings were abandoned in the thalwegs without proper (or any) rehabilitation. These mine residues pose a risk to the environment. Dahmouni also shared about his thesis, as it focuses on the reclamation of these residues, and the study of alternative and sustainable ways of reusing these, such as in construction materials.

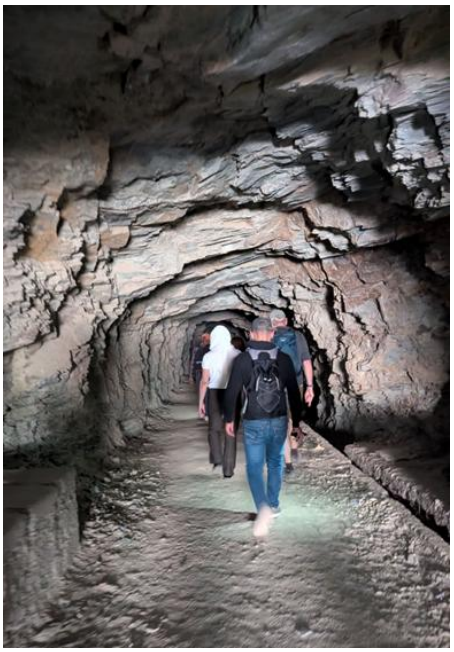
Mibladen's tailings pond

Day 4 - Midelt Mining: Ahouli
May 26, 2025

Today we went to Ahouli to visit the old mine and the old mining town. We were guided by Mouha, a former artisanal miner in Ahouli. Before getting there, we stopped at a farmer's house to pick up milk near Mibladen. This milk will be analyzed for heavy metal contamination. This farmer was located near several crystal mining holes, or "mine wells". To access this area, we had to go through a gate and a security guard, who is the son of a former miner who worked extensively with the mining company, who is securing the area while they wait to learn what happens in 2026. This area is part of a mining concession that tolerates artisanal mining, but this concession will expire in 2026. This upcoming deadline was a source of concern for the miners and the different people that we spoke to in the area, as it remains unclear who will take over the concession after, and what will happen to the miners working there, as it is unclear whether or not their activities will remain tolerated.

On our route to the farmer's house to collect the milk, Latifa noticed a very large niche of honey hives on the ground. As this area is likely to be contaminated by heavy metals deposited on the soil and plants, the consumption of this contaminated honey may lead to health risks for the population.

Ahouli was an incredibly interesting place. At a first glance, it looks like a ghost town, with several large abandoned buildings where hundreds of workers and engineers lived. It looked as if over a thousand people lived there and from one day to the next they all got up and left. Leaving a city that appeared like ancient ruins. However, the town is kept alive by informal artisanal miners who have continued exploiting the mines through one of the main galleries left by the old industrial mine.



Entrance to the main gallery, left by the old industrial mine, and now used by artisanal miners (and us)

The memory of industrial mining in Ahouli is also kept alive by a former miner who is now a custodian of the buildings left by the old mining company. His name is Mouha, the same name as our guide for Ahouli! He showed us around the city, and opened is house for us to have our lunch, protecting us from the scorching sun and later from the rain. After lunch, he played a song in the kamanja, a Moroccan violin. He shared with us his story in the mine. He was a worker in the old industrial mine, and after it closed, he became an artisanal miner. However, last year, he got injured and stopped working in the mines. He shared with us stories about life in Ahouli before the cessation of mining activities and the departure of the mining company. He shared that, although there was a clear separation between the Moroccan workers and the French engineers and managers, life was very fulfilling, referred to as "the good old days", especially regarding the workers' purchasing power and wages, as well as the festive and artistic life in Ahouli. According to him, the main cause of the halt of operations was due to workers' strikes, and due to the fall in lead prices.

We went inside the mines, led by our guide Mouha, who had worked artisanally in these mines. We walked for a long time through the main gallery, which split a few times along the way into separate galleries. The walk was easy for a while, until it wasn't. We could see remnants on the ground of the rails left by the old mine that was used to transport the mineral outside of the mine, but these have been largely covered and are no longer used. Instead, current informal miners carry from 2 to 4 bags of lead-rich mineral on bicycles.
There appears to be no overarching organization that guides, organizes, or supervises the miners; it is completely free. Each miner seems to work independently or with friends where and when they want to. The miner removes the mineral rich ore (lead, with a bit of copper) from the vein, he then smashes it with a hammer into ground form, places it in bags and finally transports it outside of the mine and of Ahouli in a bicycle.

Contrasting this with mining in Peru, Sandra wondered why under some circumstances artisanal miners organize as a group to invest in some small machinery to support their work and in others they work independently, even if they work within the same area, like here. It was suggested that they preferred the freedom of working independently, and that the price of the mineral might not be sufficiently high to justify larger investments. These are guesses, and future work could aim to identify these conditions, as higher investment in improved working conditions could be associated with safer mining practices for the miners, and higher earnings.

We did not reach the "front" of the mine because the structure of the gallery is not stable, and therefore, has a higher risk of collapse after a certain point. Although we stopped here, the miners are working in those conditions, and there have been reports of mining-related accidents that have led to deaths here.

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Visit inside the "abandoned" mines of Ahouli.
(a): Location where miners used to descend with ore (galena) extracted from upper layers; (b): Informal artisanal miner at work; (c): Mouha explaining the underground gallery to the team; (d): Galena vein associated with copper

After a tour of the mine, we visited the valley's abandoned buildings.

Abandoned buildings in Ahouli: industrial heritage.
a) Former lead processing plant located on the hillside; (b) The workers' district, the union hall, and the market; (c) The pool for the (French) engineers; (d) Interior of the former cinema hall

Then, we climbed 666 steps (Derja) up the slope to the area where the Moroccan miners used to live. It was a very strange and unsettling experience. The miners' quarters looked like ruins, a veritable ghost town called Injil. There were dozens of “streets”, each with more than a dozen small houses. In the center was the mosque in very good condition, which seemed to be the only building that remained. All the housing was destroyed by the mine company (the roof of every house was removed) and the passage of time. One gets the impression that an entire town, which existed solely for mining, was destroyed when mining ceased to be profitable for a company.

Ruins of the Injil workers' settlement.

These buildings demonstrate a stark physical separation between the type of worker in the mines. The engineers, predominantly French, lived in the mining town, with a pool, their own cinema, and close to the mines. The Moroccan miners lived in a separate neighborhood at the top of the hill, for which they had to go up hundreds of stairs after working in the mines. Despite this segregation between French engineers and Moroccan miners, Mouha recalled these times fondly, speaking on how the mining company hosted dinners with music and female dancers as entertainers.

We then went to the nearby village of Kssar Ahouliy. Here, the team visited the school.

Imad shared that the Ahouli site features a broader landscape rich in tangible and intangible elements that are in need of heritage preservation. Of notable attention are the village of Ahouli, with its mining galleries, the former industrial installations, and community facilities—still reflecting the socio-spatial segregation between Moroccans and French—as well as the nearby village of Anjil and the Ksar valley of Ahouli.

Apart from a newly established tourism cooperative (whose owner also operates a cooperative selling local products in Mibladen), no significant initiatives or actions are currently underway to promote tourism or economic alternatives in Ahouli. This is despite the fact that a clear tourist route naturally emerges, starting from an old power plant, passing by bridges, small railway lines for mining carts, the mosque, the entertainment club, the swimming pool, and continuing uphill towards the village of Anjil, then further into the valley where the Ksar is located featuring vernacular architecture (earthen dwellings) and the ancestral knowledge in its community.

As Imad shared, the cases of Mibladen and Ahouli are both rich in exceptional heritage potential which, if properly valorized, particularly through tourism, could offer an economic alternative that complements the other predominant economic activity in the area: agriculture.

After the visit to Ahouli and the village of Kssar Ahouily, we returned to Mibladen, where we shared dinner with the entire team. Sandra shared that she showed some of this day's visit to the inside the lead mine to the leader of an informal artisanal mine in Peru who expressed his interest in visiting these mines and miners and building transnational collaboration between artisanal miners working in informality. This Peruvian miner also commented on the lack of personal protective equipment seen here, as this is required in Peru, even for informal miners.

May 5 - Midelt to Jerada
May 27, 2025

Today was a transfer day from Midelt to Jerada, a distance of around 360 km. We took the road through Outat El Haj, where we had lunch, before continuing across vast pastoral plateaus. Along the way, we passed pastures occupied by herds belonging to nomadic Amazigh and Arab tribes, who continue to practice extensive livestock farming.

The doctoral school thus continued its focus by moving towards the Oriental region of Morocco, widely recognized within the scientific community for its geological, mining, and industrial potential. From Tagafayt moving towards Jerada and Guenfouda and then Oujda, the capital of the Oriental region, there are breathtaking mining landscapes with the potential to become significant tourist attractions (landscape tourism). The distinctiveness of this territory revolves around two key points: first, this was the first mining territory to be the subject of a scientific debate concerning the issue of reconversion. Second, it is also an extremely sensitive territory in social and security terms, marked by strong social demands, notably the Jerada Hirak in 2018.

Once we arrived after a long day of driving, we discussed artisanal coal mining in Jerada. This is a peculiar case study, as they were at the center of a large social conflict after two brothers died in the informal mines here. The Government, to resolve the conflict, "formalized" the coal miners by organizing them into cooperatives, and the coal that they extract is sold formally locally.

Sculptures depicting coal miners at our hotel in Guefait, near Jerada.

Day 6 - Jerada coal mines
May 28, 2025

The town of Jerada is located in Morocco's Oriental region, around sixty kilometers south of Oujda. It lies at an altitude of 1050 meters and enjoys a semi-arid climate, with hot fields, cold winters and sometimes heavy rainfall in field. Geologically, Jerada lies in a mountainous area known as the Horsts range. Its subsoil contains an ancient coal basin formed around 300 million years ago. This coal was formed from the accumulation of vegetation in swamps, gradually buried and transformed by the effects of time, pressure and temperature. The deposit contains several layers of coal, only a few of which have been mined to produce high-quality anthracite (very high calorific value).

Jerada's mining history began in 1908 with the discovery of the first signs of coal. In 1927, the presence of a large coal basin was confirmed, leading to the creation of the Société Chérifienne des Charbonnages de Jerada (S.C.C.D.) in 1929. In 1946, the workers created the first Moroccan trade union. Industrial operations began in 1933 and continued until 1998, when the mine closed for economic reasons. Mining came to a definitive end in 2001. Despite the cessation of mining, the town is still marked by its energy past: a coal-fired power station continues to generate electricity from available reserves and imported coal. Today, this plant is one of the region's main industrial hubs.

Jerada's coal-fired power station.

Our visit to Jerada began with a visit to the town center, where Dahmouni obtained the authorization from the town's administrative representative to be able to move around the town, access the industrial heritage, and visit the cooperatives.

During our visit to the old coal mine infrastructure, Dahmouni explained the history of Jerada and its mining activity. After mining operations ceased for good in 2001, the industrial infrastructure left in place today represents a remarkable heritage. These include the old quarters where Moroccan and European workers used to live, the characteristic architecture of the buildings of the time, the remains of the cableway used to transport coal to Guenfouda, the headquarters of Charbonnages du Maroc (CDM), the headframes and the large slag heaps. All these remains bear witness to the intense industrial activity that marked the region.

Large mural painting in the center of Jerada, in honour of the coal mine workers.

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We visited the former industrial sites of Jerada's coal mine, including the headframe - a former mining shaft in Hassi Belal, currently being renovated to become part of a museum park, and the old extraction shafts. We also visited the area of the coal washing and sorting facilities, and the remains of the workers' changing rooms, as well as the European quarters with its distinctive colonial architecture. Imad shared with the group how these visits highlighted the importance of heritage preservation of these elements, which embody a rich and diverse evidence of the workers' memory.

Inclined shaft (descenderie) used for subsurface coal mining in Jerada

Coal mining waste (sterile rocks) accumulated near former mining sites in Jerada

Visit to the old coal mine infrastructure of Jerada.

Elements of Jerada's Industrial Heritage: Mine Headframe and Decommissioned Thermal Power Plant

After the official closure of industrial coal mining, informal artisanal mining activities gradually took over. Today, these artisanal activities are managed in a more structured way through the creation of cooperatives that partially regulate the exploitation of residual coal. After visiting the old coal mining infrastructure, we went to visit the outside of some of these artisanal coal mines. A local miner spotted us nearby and kindly offered to guide us and show us how they work. At the end of the visit, where we saw the harsh working conditions in which they operate, including the extreme heat, this local miner told us that they deserved better conditions, given the incredible effort they put into their work. Their work occurs in 18-meter-deep vertical shafts, and they work in small groups of four workers, from 6 am to midday. They extract anthracite coal by hand.

The region has seen an increase in cases of silicosis, which is a lung disease that develops following prolonged exposure to dusty environments containing free silica. Silicosis is considered one of the most widespread and deadly occupational (minor) lung diseases. Chronic inhalation of silica particles damages the alveolar walls, triggering a chronic inflammatory response with serious consequences such as impaired lung function and respiratory distress. As a result, the authorities have taken a number of preventive and management measures for employees, patients suffering from the disease and for the general population. In our case, as observed in Jerada, we noticed that the workers are at a higher risk to suffer from silicosis due to the lack of protective measures.

Art depicting silicosis from coal mining activities in Jerada. Found on the main road of the city center.

Various formal artisanal coal mining operations in Jerada

Today, these artisanal activities are supervised by cooperatives and are considered formal by the government.

Visit to one of the artisanal coal mines in Jerada. The miner showed us how they extracted the coal from inside the vertical shaft.

After visiting the coal-mining cooperatives, we headed for the great Jerada slag heap, or the Terril. From a distance, it may appear to be just a hill, but in reality it is a huge embankment formed by the accumulation of coal mining waste. We climbed this hill made up of mine refuse, and, once at the top, enjoyed a panoramic view of the town of Jerada.

View from the top of Jerada's slag heap.

According to Dahmouni, this slag heap is one of the most emblematic features of the local landscape. Conical in shape, Dahmouni describes it as an “anthropic mound”. It rises to a height of 81 metres, with a base approximately 440 metres in diameter, covering an area of around 14 hectares. Locally referred to as the “Romblai”, it consists mainly of waste rock from anthracite mining, composed mainly of shale and, to a lesser extent, Carboniferous sandstone. Visible from afar, this blackish relief stands out clearly in the landscape. Today, its slopes are marked by numerous gullies caused by erosion. The remains of the old mining infrastructure are also clearly visible in Jerada's urban panorama.

The Symbolic Great Waste Heap of Jerada

Day 7 - Jerada to Oujda to Rabat
May 29, 2025

We started the day with a very informative meeting with Hassan Bechar, the Provincial Director of Mines and Sustainable Development of Jerada. He shared the history of coal mining in Jerada, with a particular emphasis on how different changes in the concessions led to the establishment of artisanal coal mining cooperatives. In 2001 the concession of the local coal mine was given to a mining association. The concession was then taken from the private association by the government. When the industrial coal mining closed, illegal or illicit artisanal mining started in that area. This illicit mining led to a social problem in 2018, which concluded with a negotiation between the miners and the Ministry regarding improvement in their mining operations.

Since 2018, artisanal coal miners in Jerada have joined under a small cooperatives to operate formally, with an *extraordinary permit*, which lasts 2 years, but has been consistently renewed since its inception. Each cooperative is officially owned by 5 persons and includes a total of 40 persons under the same cooperative. As incentives to promote the artisanal miners’ integration into cooperatives and secure their formalization, the government gave them health insurance, some mining equipment, and a contract to purchase their extracted coal locally. The government overviews the work of the cooperatives.

However, when we visited the mines the day before we did not see them using personal protective equipment. The Director explained that even though miners sign a document saying they received the protective equipment, they do not use it. After the meeting, the team reflected on how even in industrial mining in Canada, the miners do not consistently use the protective equipment, as this is often uncomfortable.

The Director also explained that as a result of the conflict between Russia and Ukraine, coal prices rose significantly, which led to the expansion of illegal coal mining in the area, beyond the recognized cooperatives. Since then, the Ministry has been aiming to integrate the illicit miners into the cooperatives model, so that they can operate as formal miners. Therefore, today, Jerada has both illegal and formal artisanal coal miners.

The Director shared that the vision from the Ministry for the future of coal mining in Jerada is for miners to move from artisanal cooperatives to small-scale mining enterprises. He mentioned that a current challenge that this sector has is financing and capitalization, which is an area that they will look into to resolve moving forward.

Lastly, Latifa, as a public health researcher, discussed with the Director in question their opinion on the neurobehavioral problems in the child population of Jerada, the Director confirmed that the population suffered from a number of neurobehavioral problems which indicated the need to conduct a very in-depth study on the Jerada population.

Meeting with the Provincial Director of Mines and Sustainable Development of Jerada.

After the meeting, we discussed as a team how interesting we found the socio-legal condition of these mining cooperatives, especially in contrast to how mining is formalized in other countries, including Peru. In Jerada, artisanal miners have exceptional permits, meaning this is not in the official national mining law, and this is temporary, renewing every 2 years. The team also discussed the benefits and challenges of having these short-term renewable permits, as this allowed the government to monitor this activity more closely, but the uncertainty over the continuation of their operations in the long-term could serve as a deterrence for larger investment by the miners.

After this visit, we drove to Oujda where we visited the Faculty of Letters and Humanities at the University of Mohammed I. We were welcomed by Mr. Abdeljabbar El Mediouni, Vice-Dean and Director of Scientific Research and Cooperation at the University of Mohammed I. He underlined the importance of this topic for collective memory and regional development.

Here, we attended the presentation by Professor Nouzha Boudouhou on the results of her book on the industrial heritage of the mining town of Jerada. She retraced the evolution of Jerada, from the discovery of the first coal signs by Louis Gentil in 1908, followed by the confirmation of the existence of Jerada's coal basin in Belgian geologists in 1928, to the start of the mine operations in 1933. The closure of the mine in 2001 left behind a rich industrial heritage, a testament to nearly a century of exploitation and local history. This heritage includes emblematic objects, installations and structures, such as the heaframes of the North and South shafts, a cable car linking Jerada to Guenfouda, the large slap heap of Jerada, as well as the entire historical narrative associated with it. Professor Boudouhou stressed the need to preserve and enhance this heritage through a museological park, which is currently under construction, in order to make it known nationally and internationally, both to researchers and academics, as well as to the general public, as this could be a source of development, and a way to transmit this important past to future generations.

Imad also noted that Jerada has a significant railway heritage in this province as well as in the province of Midelt, which could be harnessed for tourism.

Some final thoughts

This was the first doctoral field school that we - Hassan, Sandra, Dr. Latifa, and Dr. Imad - attended. We all believe that it was extremely valuable to work in an interdisciplinary team, bridging experiences from different expertises and locations, particularly because we all shared common hopes, for mine closure to not lead to negative economic, health, and environmental effects, for artisanal miners to operate in safe and fair working conditions, and for people to have good economic activities, beyond mining.

The interdisciplinary nature of the team in this doctoral field school was remarkable. Each had a different expertise, and as such, each member was able to shed light on a different aspect of the impacts of mining - and mine closure - on people, the environment, and potential alternative futures. As researchers, we spoke at length about "complex thinking", and the importance of communication across different fields when we discuss mining in order to see "the bigger picture".

Finally, we all spoke different languages. And although this journal is written in English, which is not the first language of any of its authors, we found a combination of different languages (French, Darija, Amazigh), phone applications, websites, (and even hand gestures!) to communicate with each other, all of this in the hopes of finding practical ways to link lessons learned across regions.