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# A field trial demonstrating $CO_2$ removal through enhanced weathering in mine tailings: design, commissioning and early performance of a European Union-funded pilot

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## Abstract

*Tailings from mafic and ultramafic mines can be utilised to neutralise acids, and capture and store carbon dioxide ($CO_2$) via enhanced rock weathering (ERW). As part of the European Union (EU)-funded C-SINK project, Boliden's active Kevitsa Mine, Finland, hosts a field trial to develop scalable monitoring, reporting and verification (MRV) for carbon dioxide removal (CDR).*

*At Kevitsa, a 2 m deep, 25 $m^2$ filtered tailings test cell was installed in August 2025 to quantify ERW-driven CDR and establish a mine-ready MRV approach. Filled with filtered tailings, the cell is equipped with 3 vertical stations, with ports at various depths. Each port includes $CO_2$ and oxygen ($O_2$) sensors plus temperature, water content and electrical conductivity (EC) probes, for continuous, depth-controlled pore/void monitoring. A pH probe tracks near-surface changes.*

*To capture reaction products and quantify carbon flux, a drainage well with an autosampler collects leachate for laboratory analysis of pH, EC, alkalinity, dissolved inorganic carbon, major cations/anions and trace elements. Determination of CDR is carried out using these sensor and leachate chemistry data, coupled with periodic solid-phase sampling of tailings for in situ carbonate formation evidence.*

*This paper reports:*

1. *practical design of the test cell (cell and drainage system architecture, sensor setup and protection)*
2. *commissioning, quality assurance and control of multi-depth gas and moisture measurements*
3. *an MRV approach linking time- and depth-varying $CO_2$/$O_2$, moisture, EC and temperature to mineral dissolution/precipitation dynamics controlling CDR.*

*This study assesses how these data streams can estimate $CO_2$ drawdown and support sustainable upscaling of ERW deployment at tailings storage facilities (TSF) during mine operation and closure.*

*To our knowledge, this is the first EU pilot testing MRV for ERW of tailings at an active mine, combining continuous multi-depth flux monitoring with systematic leachate and solid-phase chemistry data to provide a scalable pathway for long-term sustainable CDR at a TSF.*

**Keywords:** *enhanced weathering, mineral carbonation, mine tailings, carbon dioxide removal, MRV methodology*

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# 1 Introduction

## 1.1 Background

Mine waste management has typically focused on geotechnical stability and the prevention of acid and metalliferous drainage (AMD). However, there is increasing awareness that mine wastes, especially mafic and ultramafic tailings, have the potential to capture atmospheric carbon dioxide ($CO_2$) through mineral carbonation (Wilson et al. 2014; Bullock et al. 2022; Power et al. 2025; Shiimi et al. 2025). Enhanced rock weathering (ERW) leverages the natural dissolution of silicate mineral such as olivine, pyroxene and serpentine, to form stable carbonate minerals that store $CO_2$ for geological timescales (Renforth 2019; Abdalqadir et al. 2024).

Studies show that ultramafic tailings can absorb between 3 and 24 t $CO_2$ per hectare per year of reactive MgO over decadal timescales (Wilson et al. 2014; Paulo et al. 2023). Combining ERW with mining operations supports both carbon neutrality goals and responsible mine closure strategies (Stokreef et al. 2022; Shiimi et al. 2025).

The EU-funded Horizon C-SINK project aims to develop a standardised and transparent European carbon dioxide removal (CDR) market. In this context, Mine Environment Management (MEM) Ltd and Boliden AB collaborate to demonstrate monitoring, reporting and verification (MRV) scalability in an ERW field trial. Boliden's Kevitsa Mine in northern Finland was selected as the field demonstration site for an in situ ERW trial using filtered tailings. The Kevitsa pilot represents a major step from laboratory research (Savage 2019, 2023; Shiimi 2022; Schoen 2022; Cole 2023; Clancy 2024) towards operational scale MRV testing.

## 1.2 Objectives

This paper presents the design, commissioning and initial results of the Kevitsa ERW field trial. The specific objectives are to:

- design and build a monitoring test cell that simulates stacked filtered tailings conditions
- implement continuous multi-depth monitoring of porewater and void space at multiple depths to measure $CO_2$ and oxygen ($O_2$) fluxes
- combine gas, liquid and solid-phase data into an MRV framework for quantifying CDR
- evaluate how ERW and associated MRV requirements can be incorporated into operational tailings management and closure planning
- assess the potential contribution of mine-tailings-based CDR for net zero mining objectives and the generation of verifiable carbon credits.

## 1.3 Gas flux and mineral carbonation

Enhanced rock weathering using mafic and ultramafic rocks is an emerging CDR technology that has recently received renewed attention in the mining industry (Smith et al. 2024). Mineral carbonation is a process in which atmospheric $CO_2$ reacts with calcium (Ca)-rich, magnesium (Mg)-rich, and iron (Fe)-rich silicate minerals to form chemically stable carbonate minerals (Rackley 2017; Li et al. 2018). This enables $CO_2$ to be stored in long-term carbon sinks, with carbon retained in solid mineral phases over geological time scales.

Aqueous carbonation, the weathering and release of cations from Mg-silicates and Ca-silicates in the presence of water, encompasses 2 main steps:

- the dissolution of Mg-silicates or Ca-silicates
- the precipitation of carbonates.

The simplified reaction process of mineral carbonation is shown in Figure 1 and Equation 1 (Li et al. 2018).

$$(Mg, Ca, Fe)\,SiO_4\,(s) + CO_2\,(g) \rightarrow MgCO_3\,(s) + SiO_2\,(s) \quad (1)$$

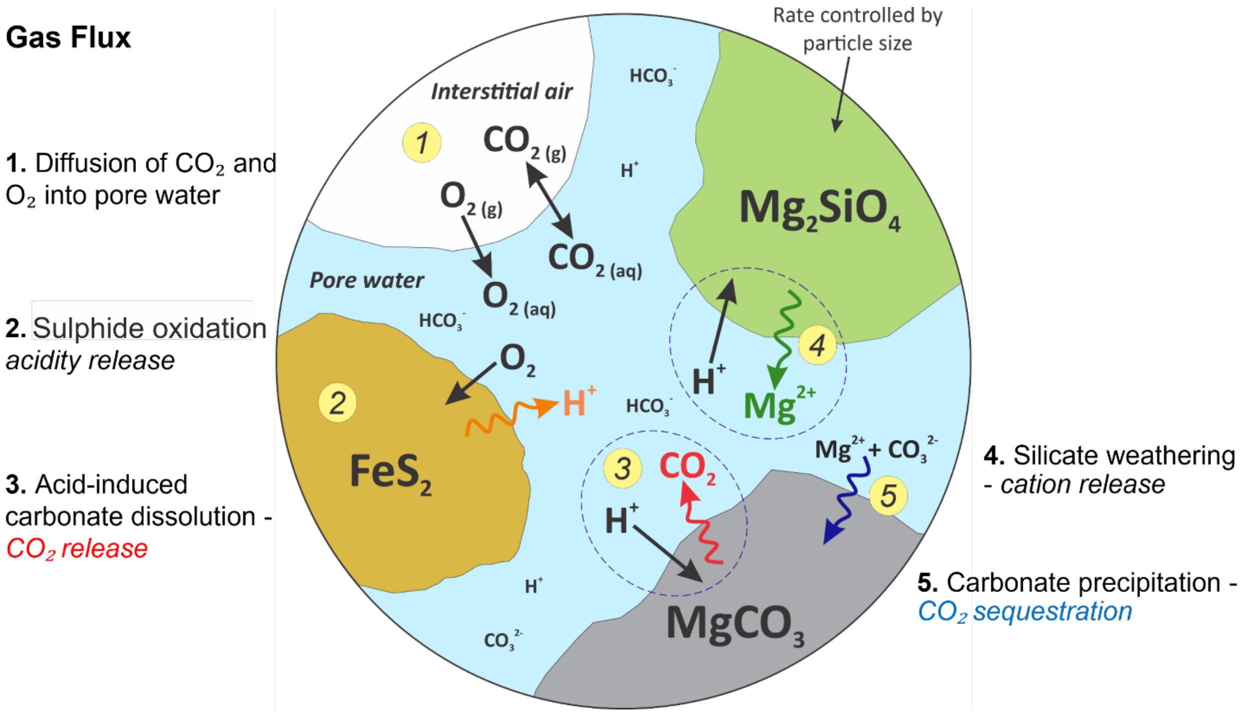


**Figure 1 Simplified schematic diagram of pore gas flux in mine wastes (modified from Gras et al. 2017)**

However, if sulphide minerals are present in the waste rock and tailings, their oxidation may generate acidity release through sulphuric acid ($H_2SO_4$). This acidity may lead to the dissolution of potential carbonate minerals already occurring in the material. For example, the dominant sulphide and carbonate mineral phases of the material used in this study are pyrrhotite ($Fe_{1-x}S$) and dolomite ($CaMg(CO_3)_2$). The oxidation reaction for pyrrhotite generates acidity followed by dolomite-induced dissolution, and the release of $CO_2$. The stoichiometric relationship between pyrrhotite and dolomite neutralisation shows that for every 1 mole of $O_2$ consumed, 0.44 moles of $CO_2$ are produced (Barnes et al. 2022; Shiimi et al. 2024). The kinetics of this process are controlled by several rate-limiting factors: mineralogy, reactive surface area (related material granulometry), pH, temperature, $O_2$ and $CO_2$ concentration and water saturation (Stokreef et al. 2022).

# 2 Methodology

## 2.1 Site overview

The Kevitsa Ni-Cu-PGE mine, operated by Boliden AB, is located near Sodankylä, northern Finland. The deposit hosts sulphide mineralisation within a mafic-ultramafic intrusion. The host rocks of the ore deposit are ultramafic, mainly olivine websterite and olivine pyroxenite. The mafic unit is made up of gabbro, ferrogabbro, and magnetite gabbro. Amphibole and serpentine-chlorite alteration is prevalent throughout the intrusion and obscures primary relationships (Santaguida et al. 2015).

Tailings are produced from flotation processing and are stored as filtered tailings in a dedicated tailings storage facility (TSF). The climate is sub-arctic, with a mean annual air temperature of −1.8°C and annual precipitation around 550 mm. This creates a suitable environment for long-term ERW testing in a temperate, moisture-sufficient setting.

## 2.2 Test cell construction

A 2 m deep, 25 $m^2$ test cell was constructed at the northwestern margin of the Kevitsa TSF (Figure 2). The test cell was filled with tailings and instrumented with sensors in August 2025. The base of the cell was lined with an impermeable geomembrane to isolate inflow and outflow from the surrounding area. A drain coil pipe was placed at the base of the cell to collect leachate and discharge it into a leachate collection well on the outside of the test cell. The drain coil pipe is covered with a small quantity of usable waste rock to prevent the fine tailings material from blocking its perforations. The leachate collection cup is located outside the pit and contains electrical conductivity (EC) and pH probes for analysis. A pipe connects the leachate collection cup to an automatic sampler, which collects 300-mL samples of leachate for chemical analysis. An overflow pipe is located at the top of the cell to drain excess water.

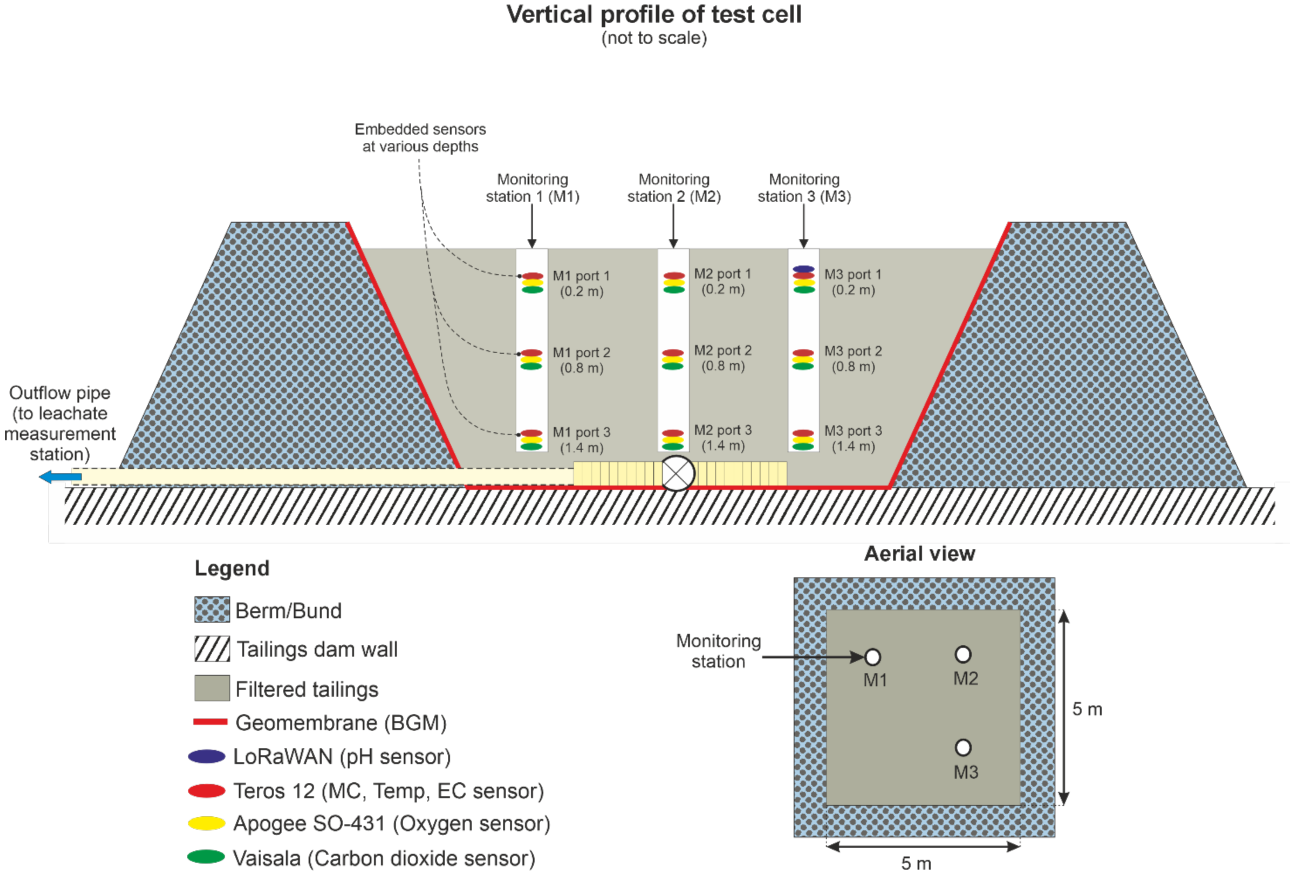


**Figure 2** **Pilot test cell design and setup with a monitoring stations and ports with sensors at various depths**

## 2.3 Instrumentation and sensors

Three vertical monitoring stations (M1, M2, M3) were set up inside the tailings test cell (Figure 2). Each station had 3 sensor ports located at depths of 0.2, 0.8 and 1.4 m below the surface. At each port, $O_2$ and $CO_2$ sensors were placed in perforated HDPE protective casings covered with a permeable membrane. These casings protect the probes from tailings particles and debris while also ensuring gas exchange with the pore spaces. Alongside these sensors, temperature, volumetric water content, and EC probes were placed directly in the tailings. This setup allows for monitoring of changes in moisture and geochemical conditions over time and depth. At monitoring station M3, a pH sensor was added at a depth of 0.2 m to capture near-surface chemical variations. This information supports the understanding of carbonate buffering and dissolution processes. Table 1 summarises the sensor types, installation configuration, depth placement and monitoring objectives for each instrument used within the test cell.

**Table 1 Summary of sensor types and installation configuration within the Kevitsa ERW field test cell**

| Sensor type | Purpose/description |
|---|---|
| Oxygen ($O_2$) sensor (Apogee SO-431) | Monitors $O_2$ concentration within the tailings to track $O_2$ flux and quantify oxidative and weathering processes. Nine $O_2$ probes were installed at 3 monitoring stations at depths of 0.2, 0.8 and 1.4 m. Each probe was placed in a perforated HDPE protective tube to keep tailings and debris clear of the probe and to ensure accurate measurements. The $O_2$ probes were set up vertically to promote steady gas diffusion and reliable readings. |
| Carbon dioxide ($CO_2$) sensor (Vaisala GMP 252) | Monitors $CO_2$ concentration within the tailings to track carbon flux and monitor carbonation activities. Nine $CO_2$ sensors were installed at three monitoring station at depths of 0.2, 0.8 and 1.4 m. Each $CO_2$ probe was placed in a perforated HDPE tube to protect the sensor from tailings particles and debris. The $CO_2$ sensors were installed horizontally to improve gas sampling from the pore space. |
| Temperature, EC and water content sensor (TEROS 12) | Monitors temperature, EC and volumetric water content within the tailings to check moisture changes and geochemical conditions that influence mineral weathering. Nine TEROS sensors were installed directly into the tailings at three monitoring station at 3 depths: 0.2, 0.8 and 1.4 m. |
| pH sensor (LSPH01 LoRaWAN) | Monitors pH changes in near-surface tailings to identify changes in acidity and carbonate buffering. One pH sensor was installed at a depth of 0.2 m at monitoring station 3 (M3). The probe was placed directly into the tailings to allow for high-sensitivity measurements and easy removal for maintenance. |

## 2.4 Leachate collection

A leachate sampling cup (Figure 3b) was installed below the inflow pipe of the leachate well (Figure 3a) to capture percolating drainage water from the test cell. A sampling tube and water level sensor were also installed for automatic sample collection and water level control (Figure 3c). The level sensor was mounted so that the probe tip rested at the base of the cup. The sampling tube inlet was placed a couple of centimetres (~2 cm) above the base to reduce sediment uptake.

Within the cup, a pH and EC sensor were installed, suspended from their cables without protective installation pipes to ensure direct contact with the leachate (Figure 3c). The pH probe was enclosed in a storage cup that was perforated to allow free exchange with the surrounding water while protecting the sensor tip from damage and drying out.

The sampling cup was designed with an overflow outlet to release excess leachate once the cup volume reached about 500 mL. When the liquid level rises to the preset threshold of 5 mm below the overflow, the datalogger automatically triggers the autosampler to collect a sample. Each sampling event is set to withdraw about 300 mL of leachate. Under standard operation, the automatic sampler (Figure 3d) is set to collect one sample per day; however, this frequency can be adjusted as needed to accommodate changes in flow (rainfall) or research requirements.

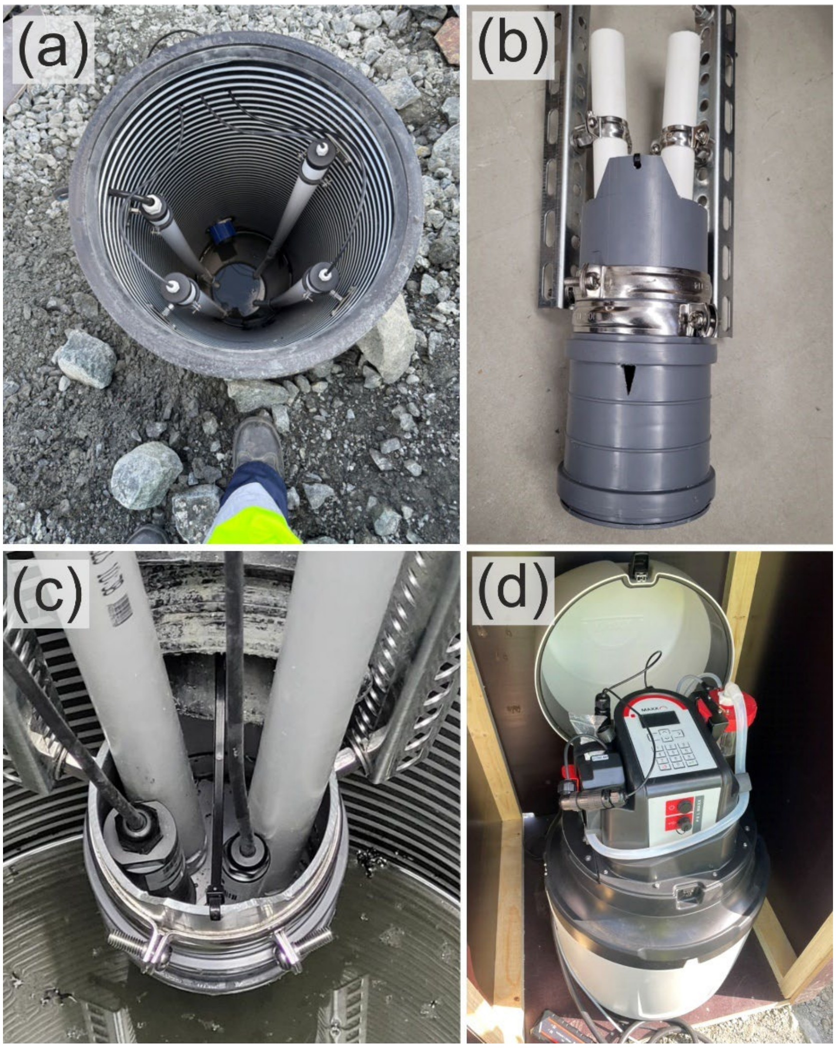


**Figure 3 (a) Leachate collection well installed at the base of the test cell; (b) Leachate sampling cup; (c) Sampling cup showing sampling tube, water level sensor, and pH and electrical conductivity probes; (d) Automatic sampler used for leachate collection and storage**

# 3 Results

## 3.1 Baseline tailings composition

The filtered tailings examined in this study originate from a low-sulphide mafic to ultramafic rock type and are characterised by their capacity to undergo carbonation weathering reactions when exposed to ambient environmental conditions. Data from automated mineralogy show that the tailings mainly consist of mafic minerals including pyroxene (~45 wt.%), amphibole (~20–30 wt.%), and olivine (~10–20 wt.%). Diopside (60 wt.%) and enstatite (25 wt.%) are the main Mg-bearing minerals, with tremolite present in low concentrations (7 wt.%). The principal source of Ca is diopside (Shiimi 2022; Shiimi et al. 2025).

Mineral carbonation in the tailings mainly occurs through the dissolution of diopside, enstatite, olivine and tremolite, which leads to the precipitation of secondary carbonate minerals under favourable geochemical conditions. Pyrrhotite (~0.1–2.9 wt.%) and dolomite (0.1–0.4 wt.%) were identified to be the main sulphide and carbonate phases, respectively. Therefore, sulphide oxidation within the tailings is primarily associated with pyrrhotite, while acid neutralisation is due to dolomite dissolution and silicate weathering.

Based on bulk elemental analysis, the carbon capture potential (CCP) of the tailings is estimated to be approximately 330 kg $CO_2$ per tonne of material (Shiimi et al. 2025). This relatively high CCP value highlights the presence of reactive Mg-bearing silicate (e.g. diopside, amphibole, and olivine) minerals which support long-term carbon dioxide storage through weathering and mineral carbonation processes.

## 3.2 Sensor data and data quality

Continuous logging and monitoring of gas and porewater parameters began in August 2025, and this paper includes data until October 2025. The results shown below are from monitoring station M3 only. The monitoring system worked properly during this time and the dataset provides an insight into the early-stage geochemical and environmental behaviour of the Kevitsa ERW tailings test cell. Sensor data are checked daily for transmission, outliers, and calibration drift. Overall, data continuity was above 99%, which confirms the loggers performed reliably and that the multi-depth sensor setup is working effectively.

### *3.2.1 Moisture content, electrical conductivity and temperature*

Moisture content, EC, and temperature are being continuously monitored at depths of 0.2, 0.8, and 1.4 m (Figure 4).

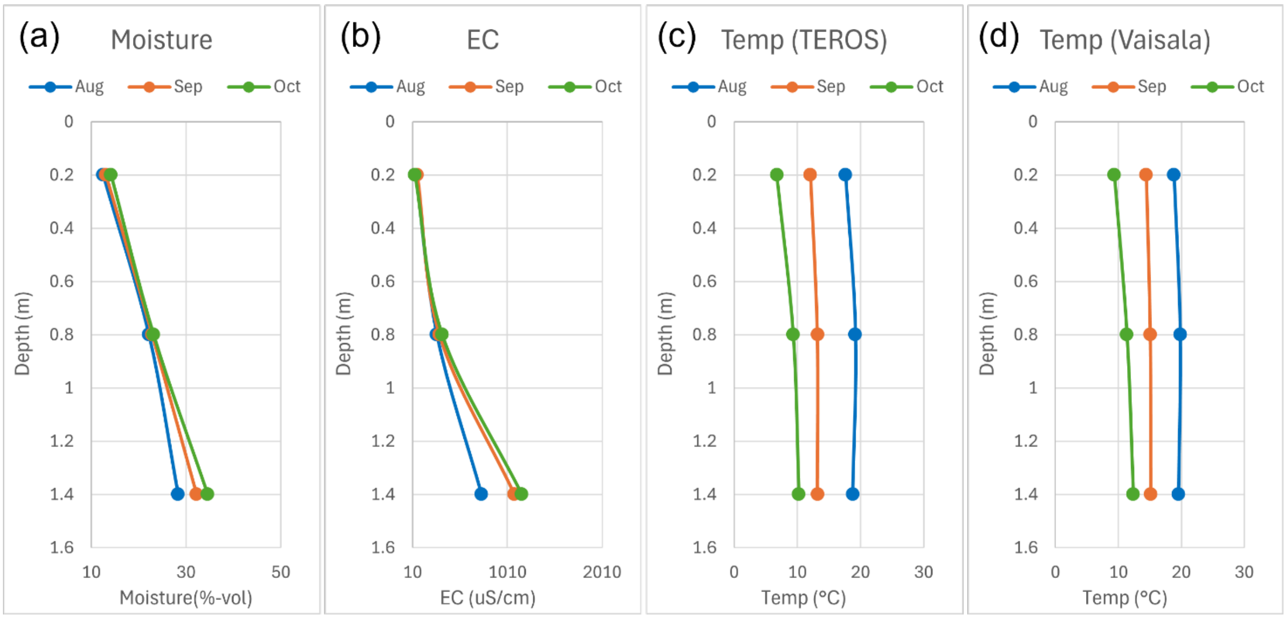


**Figure 4 Depth profiles of (a) volumetric moisture content, (b) electrical conductivity, (c) temperature measured by TEROS sensors, and (d) temperature measured by Vaisala sensors at 0.2, 0.8, and 1.4 m depths for August, September, and October 2025**

#### *3.2.1.1 Moisture content*

The volumetric water content ranged from 12 to 35% across all depths. The top layer (0.2 m) had the lowest moisture values, averaging around 13%. The moisture content gradually increased towards the middle layer (0.8 m) and bottom layer (1.4 m), averaging about 23 and 31%, respectively. The moisture content stayed consistent from August to October with minimal changes over time at the respective depth layers.

#### *3.2.1.2 Electrical conductivity*

EC values ranged from about 40 to 1,200 µS/cm, showing a general increase with depth. The top port (0.2 m) consistently had the lowest EC values, averaging around 46 µS/cm, whereas the middle and bottom depths averaged about 290 and 1,000 µS/cm, respectively. Measurements remained stable during the monitoring period.

### 3.2.1.3 Temperature

Both TEROS and Vaisala temperature sensors recorded values between 6 and 20°C at all depths. August recorded the highest temperature across all depths, followed by a gradual temperature decrease through September to October. The top layer (0.2 m) showed slightly lower temperatures, averaging 12–14°C. Temperatures in the middle layer (0.8 m) and bottom layer (1.4 m) slightly increased, averaging 13–15°C and 14–15°C, respectively. Temperature profiles stayed similar for both TEROS and Vaisala sensors throughout the monitoring period.

### 3.2.2 pH sensor

The pH and temperature were continuously monitored at the surface (0.2 m depth) over 3 months (Figure 5). During this monitoring period, pH values ranged from 5.5 to 7.2. In August, the average readings were around pH 6.9. Subsequently, there was a gradual decline through late August, reaching a low of about pH 6.3 in early September. The pH remained stable through October, averaging around 6.3.

Temperature recorded by both the pH probe and the TEROS sensor at the same 0.2 m depth ranged from 3 to 21°C during this time. The 2 sensors measured similar temperature profiles, confirming that the independent measurements were consistent.

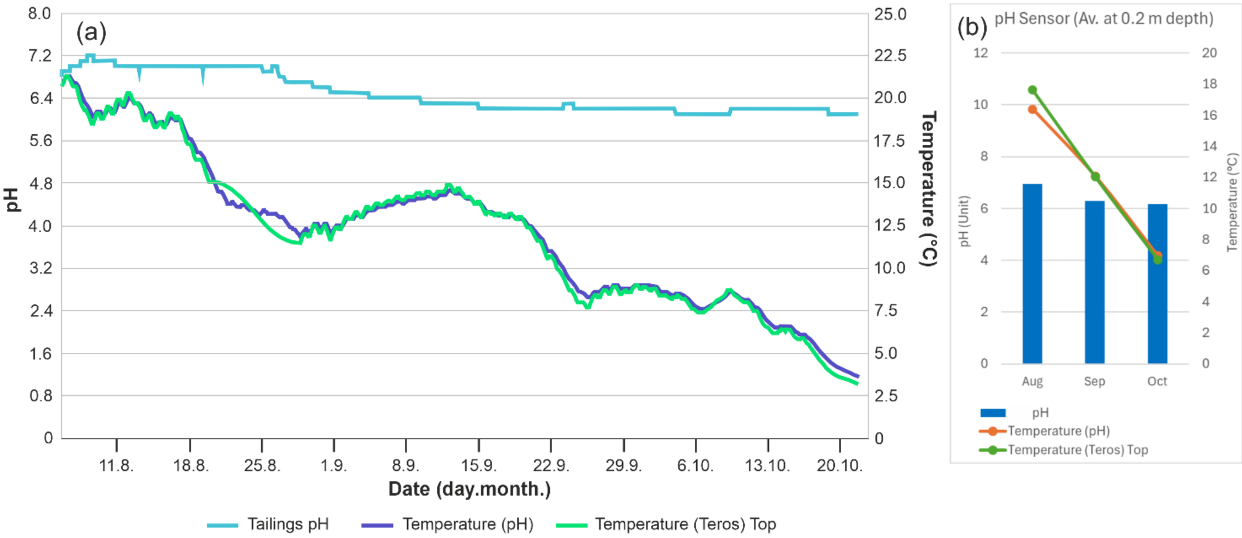


**Figure 5 (a) Time series of pH and temperature measured at 0.2 m depth from August to October 2025; (b) Average pH and corresponding temperature recorded by the pH and TEROS sensors**

### 3.2.3 Carbon dioxide and oxygen concentrations

At station M3, $CO_2$ and $O_2$ concentrations were continuously recorded at 3 depths: 0.2, 0.8, and 1.4 m, from 10 August to 16 October 2025 (Figure 6a).

$CO_2$ concentrations at all depths range from 270 to 540 ppm (Figure 6b). The surface layer (0.2 m) showed the highest variability in $CO_2$ concentrations, rising from ~180 ppm in August to ~480 ppm in September, followed by a gradual decrease to ~340 ppm in October. Carbon dioxide in the middle depth (0.8 m) showed a steady increase from ~200 ppm in August to ~500 ppm in September, followed by a slight decrease stabilising at an average of ~400 ppm in October. The bottom layer (1.4 m) recorded the lowest $CO_2$ concentrations in August (~270 ppm), which increased progressively through September and October, reaching ~540 ppm in October. This was also the highest $CO_2$ concentration recorded at all depths.

$O_2$ levels ranged from 20 to 25% across all depth from August to October (Figure 6c). The top layer (0.2 m) recorded the highest $O_2$ concentration above atmospheric levels at around 24%. This will be investigated through calibration checks and review of sensor compensation for temperature and moisture. The middle (0.8 m) and bottom (1.4 m) layers showed slightly lower concentration, with $O_2$ decreasing with depth from 24% near the surface to ~21% at 1.4 m.

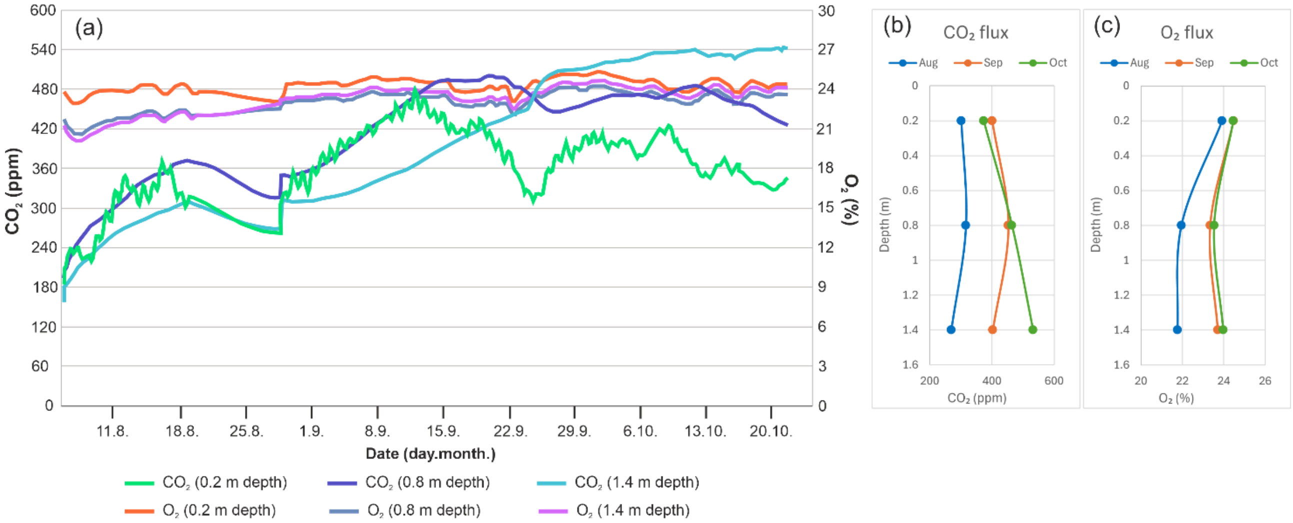


**Figure 6** **Time series and depth profiles of $CO_2$ and $O_2$ concentrations measured within the Kevitsa test cell station M3 from August to October 2025. (a) continuous $CO_2$ and $O_2$ concentration data at 0.2, 0.8, and 1.4 m depths; (b and c) depth profiles showing**

# 4 Discussion

The 3-month pilot dataset in this study shows that the Kevitsa ERW test cell setup offers a stable and well-equipped setting for monitoring CDR in filtered tailings.

## 4.1 Gas dynamics and subsurface reactivity

The multi-depth sensor data show clear and time-dependent changes in $CO_2$ and $O_2$ levels. The rise in $CO_2$, along with the decline in $O_2$ with depth, indicates reactive vertical flux transportation through the pore spaces, and potential consumption and release processes in contact with the tailings material. Carbon dioxide builds up with depth, reaching over 500 ppm after three months of continuous monitoring. Carbon dioxide accumulation in the lower parts of the cell indicates potential carbonate precipitation reactions between fluxes and tailings grains (Power et al. 2013; Harrison et al. 2012). The relatively high and stable $O_2$ concentrations at all depths indicate that oxidative conditions remain, which support ongoing mineral weathering and possible sulphide oxidation (Barnes et al. 2022). These early signs align with environments that favour $CO_2$ absorption through improved weathering pathways (Renforth 2019; Shiimi et al. 2025).

## 4.2 Hydrogeochemical behaviour

The EC and moisture results show that the test cell remains unsaturated but moist, with a water content of 20 to 35%. These conditions are suitable for both gas diffusion and weathering through water (Stokreef et al. 2022; Knapp et al. 2023). The overall rise in EC with depth and the stable near-neutral pH (6.3 to 7.2) suggest limited solute production and some buffering in the porewater. Temperature variations range from 6 to 20°C, following seasonal changes at the surface, yet remain within a range that allows slow mineral dissolution typical of sub-arctic climates (Abdalqadir et al. 2024). Overall, these factors indicate that the test cell effectively simulates realistic near-surface conditions for long-term evaluation of enhanced weathering of tailings.

## 4.3 Next steps

### *4.3.1 Leachate and solid-phase chemistry*

Future sampling campaigns will include leachate collection from the test cell to characterise aqueous geochemical processes linked to carbonate dissolution and precipitation. Planned analyses include dissolved inorganic carbon, total carbon (C), total sulphur (S), major and trace cations and anions, pH, and alkalinity.

These data will be used to assess the geochemical changes in porewater and quantify CDR using both the alkalinity-based and cation-balance methods (Renforth 2019).

Samples were collected during the installation of the test cell for feedstock (baseline) characterisation (mineralogical and bulk chemical analysis). The next sampling phase, scheduled for summer 2026, will involve sampling of tailings collected vertically using a hand auger to a depth of 1.4 m to recover representative material from each monitoring layer. The mineralogical and geochemical results after the trial will be compared to the baseline composition, to identify evidence of formation of secondary carbonate minerals and mineral carbonation within the tailings matrix.

#### *4.3.2 Integrating datasets for monitoring, reporting, and verification*

To develop a solid MRV methodology for quantifying CDR in mine tailings, sensor data, leachate chemistry, and solid-phase mineral data from the test cell will be combined. The merged datasets will allow us to use a mass balance approach to determine the net carbon flux. This connects the exchange of gaseous $CO_2$ (from $CO_2$/$O_2$ sensors) with aqueous carbon species (from leachate chemistry) and the accumulation of solid carbonates (from mineral and total inorganic carbon analyses).

Integration of these datasets will assist in getting a deeper understanding of the gas-liquid-solid interactions in a tailings system and provide new real-life evidence for $CO_2$ uptake and storage through mineral carbonation processes. This MRV methodology is in line with other laboratory-based methods for assessing mine waste CDR (Barnes et al. 2022; Savage et al. 2023; Shiimi et al. 2024) and supports long-term verification of $CO_2$ storage performance.

### 4.4 Implications for monitoring and monitoring, reporting, and verification development

The integration of gas, aqueous and solid-phase data sets will aid in estimating CDR using both the alkalinity-based and cation-balance methods (Renforth 2019) and in developing a strong mass-balance-based MRV methodology for CDR on mine wastes. The planned approach follows international enhanced weathering protocols, like Isometric (Sutherland et al. 2025), by linking measurable, verifiable indicators of carbon capture and storage between phases and enabling reproducible calculations of $CO_2$ removal using mining waste material. The Kevitsa ERW pilot trial is one of the first field-scale examples in Europe for continuous ERW monitoring in filtered tailings, offering a case study for future implementation of CDR at mine sites.

### 4.5 Lessons learned

Several lessons were learned during the first monitoring phase:

- Importance of site location: climate and temperature variations (e.g. cold climate sites require selecting sensors capable of operating reliably in sub-zero temperatures). Sensor housings were designed to prevent freezing and condensation ($O_2$ and $CO_2$ sensors include an integrated heater to prevent condensation).
- Sensor sensitivity: sensors are highly sensitive to environmental conditions such as condensation, dust and moisture. To protect them, each sensor was placed inside a perforated HDPE protective casing wrapped with a permeable membrane before being buried in the tailings.
- pH sensor (LoRaWAN): as neither MEM Ltd nor Mitta OY had prior experience with this pH probe, it was decided to initially install only one pH probe at a single near-surface monitoring station. This allows easy removal if the probe malfunctions and for periodic calibration. Placing the probe at the surface enables easy access for maintenance and reinstallation after calibration. Secondary measurement of leachate pH (lab analysis) is used to validate sensor pH data.
- Material type and particle size: mine wastes with sulphides (acid mine drainage [AMD] risk) and carbonates are likely to emit $CO_2$ as a result of carbonate buffering of AMD. Grain size and material

texture influence the choice of pH and moisture sensors. Site-specific calibration is required to ensure accurate pH, moisture and EC readings.

- Accessibility and automation: autonomous monitoring offers minimal involvement from contractors or mine staff for maintenance and data collection. The data logging system automatically records and transmits data to an online platform, allowing real-time visualisation, remote data downloading and generation of trend plots. This setup eliminates the need for frequent site visits, ensures continuous data availability, and allows rapid checks for potential errors and any potential malfunction.
- Data continuity: regular remote data transmission and automated calibration checks kept data quality high, with over 99% completeness.
- Environmental responsiveness: the test cell sensors effectively capture changes in temperature, moisture, and gas due to weather events. This confirms that the system can track subtle environmental changes.
- Operational readiness: the pilot showed that small-scale field installations can run efficiently at active mine sites. This provides a basis for scaling up CDR MRV as part of ongoing tailings management.

These lessons provide a useful guide for the next phase of this project and a basis for setting up similar projects at other mines. Additionally, these lessons will help refine sensor placement, drainage design, and sampling frequency for future MRV development.

# 5 Conclusion

Early results from the Kevitsa ERW pilot show that the field cell design and sensor network are effective for continuous, multi-depth monitoring of $CO_2$, $O_2$, moisture, EC, pH, and temperature in filtered tailings. The initial three-month dataset suggests stable conditions within the tailings. These conditions are marked by slight vertical gradients in gas and moisture, and by nearly neutral pH that supports $CO_2$ capture in solid or liquid form. Even at early-stage conditions, the environmental and geochemical trends recorded suggest active interactions between the tailings mineral matrix and percolating fluxes at changing atmospheric conditions and different depths.

Although leachate collection data were not available during this first testing phase, future campaigns will include porewater chemistry and solid-phase mineral data to assess geochemical changes and measure CDR. These data will help create the basis for a complete MRV methodology for CDR in mine tailings. Thus, the Kevitsa pilot shows that field-scale ERW monitoring can work in an operational setting. It also represents an important step towards responsible and scalable CDR using mine wastes in cold climates.

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