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# Preliminary Assessment of the Potential for Enhanced Rock Weathering in Ghana

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## Executive Summary

Climate change poses urgent threats to Ghana's socio-economic stability, food security, and ecosystems. Achieving the country's Nationally Determined Contributions (NDCs) to the Paris Agreement to reduce greenhouse gas (GHG) emissions by at least 15% by 2030 and the 2070 net-zero target requires aggressive deployment of all viable carbon dioxide removal (CDR) strategies. To achieve these ambitious targets, the country must maximize the use of all available carbon sinks to capture and store anthropogenic emissions. Enhanced Rock Weathering (ERW) is a high-potential CDR approach which has not yet received adequate attention in Ghana despite its promising mitigation potential. This policy brief presents preliminary findings on the potential for ERW in Ghana. Preliminary assessments indicate that the country has favorable conditions for ERW deployment, including a tropical climate that accelerates silicate weathering and abundant, accessible geological resources. These resources include high-purity olivine deposits in the Aketakyi Ultramafic Complex and widespread basalt, which can be sourced sustainably from mine tailings in the gold sector, establishing a low-cost supply chain for ERW implementation. Beyond climate mitigation ERW offers substantial co-benefits. It can improve soil fertility, enhance alkalinity, supply essential crop nutrients, strengthen food security, generate rural employment, and create revenue opportunities through verified carbon credits in global markets. Strategic investment and policy support for ERW can thus position Ghana as a regional leader in sustainable CDR deployment while simultaneously advancing climate resilience and economic development.

## Keywords:

Climate Action, GHG Mitigation, Enhanced Rock Weathering, Carbon Dioxide Removal, Net-Zero GHG Emissions, Climate-Smart Agriculture,

## Policy Recommendations

1. Incorporate ERW in Ghana's NDC implementation plan and Climate-Smart Agriculture strategy, with clear targets.
2. Develop ERW-specific monitoring, reporting, and verification (MRV) standards and approve ERW as an eligible activity under Ghana's carbon market framework for Article 6 transactions.
3. Establish funded pilot projects in agro-ecological zones in partnership with KNUST, CSIR, and EPA to measure CO<sub>2</sub> removal, soil impacts, and crop response using Ghanaian feedstocks.
4. Mandate and incentivise formal agreements with mining and quarry operators to supply suitable waste rock for ERW pilots and future deployment.

## Introduction

Enhanced Rock Weathering (ERW) is a carbon dioxide removal (CDR) technique that accelerates a natural process by which CO<sub>2</sub> is removed from the atmosphere and stored safely in soils and water over long periods. In nature, CO<sub>2</sub> dissolves in rainwater to form a weak acid, which reacts with silicate minerals in rocks. When finely ground reactive rocks are applied to soils, this process is greatly accelerated, leading to the release of beneficial minerals such as magnesium and the formation of stable bicarbonate and carbonate compounds that effectively lock away carbon. The effectiveness of ERW depends on how fast the reactions occur (reactivity) and how favourable the environmental conditions are (favourability). Reactivity is influenced by the type and surface area of the rock used, while favourability depends on local conditions such as soil chemistry, rainfall, temperature, and land management practices. Together, these factors determine how much CO<sub>2</sub> can be removed and securely stored, either by dissolving them in soil water or converted into stable carbonate minerals. ERW operates through mineral dissolution, where CO<sub>2</sub> reacts with crushed rock, and carbonation, where the captured carbon is stabilised in long-lasting chemical forms. This makes ERW a scientifically robust and low-risk option for long-term carbon removal when properly implemented and monitored. The dissolution phase begins with the dissolution of CO<sub>2</sub> in water to form carbonic acid.



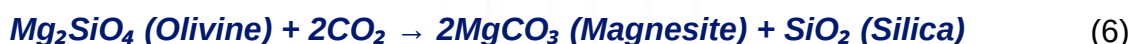
The weathering process is followed by the breakdown of silicate minerals by carbonic acid to release cations (Mg<sup>2+</sup>, Ca<sup>2+</sup>, Fe<sup>2+</sup>).



The carbonation then follows subsequently to form stable carbonates.



When the rocks weather, they release essential nutrients such as calcium, magnesium, and potassium, which can enhance crop yields and reduce the need for fertilizer:



Global evidence indicates that ERW can deliver substantial agricultural and climate benefits simultaneously. Field trials in multiple countries show consistent improvements in crop yields, soil health, and carbon sequestration [1].

In the United Kingdom, the application of finely ground basalt increased spring oat yields by over 20% and sorghum yields by about 21%, demonstrating clear productivity gains for staple crops [2, 3]. Similar results have been observed in the United States, where long-term trials from the Corn Belt and farms in New England recorded improvements in soil quality, including increases in soil organic carbon ranging from 69% to 135%, and large rises in plant-available nutrients such as calcium, magnesium, and potassium by 62% to 252% [4]. Beyond productivity, ERW also delivers meaningful climate mitigation outcomes. These same studies estimate carbon dioxide removal rates of approximately 2 to 4 tonnes of CO<sub>2</sub> per hectare per year, depending on soil type, climate, and application rates [3]. This means ERW functions not only as a soil amendment but also as a scalable carbon removal pathway that can be integrated into existing farming systems without disrupting food production.

## Geological Suitability of Ghana

Preliminary geological assessments in Ghana have identified dunite and basalt as the most suitable feedstocks for ERW [5]. These rock types belong to the silicate family, which is widely recognised as the most effective for long-term carbon dioxide removal through mineral weathering processes. However, suitability is not determined by rock type alone. The rate and durability of CO<sub>2</sub> removal depend strongly on mineral composition as well as environmental conditions such as temperature and humidity, which influence weathering kinetics [6]. Detailed mineralogical analyses of candidate deposits indicate the presence of highly reactive minerals, including olivine, pyroxene, and plagioclase feldspar, together with amorphous basaltic glass [7]. Among these, olivine-rich rocks exhibit the fastest reaction rates and the highest CO<sub>2</sub> uptake potential. Dunite contains exceptionally high concentrations of magnesium-rich olivine and demonstrates favourable weathering kinetics, making it especially effective for rapid and permanent CO<sub>2</sub> sequestration [8, 9]. Table 1 shows specific areas in Ghana with these olivine-rich basaltic rocks that could be potential candidates for ERW.

**Table 1. Areas in Ghana with olivine-rich basaltic rocks**

| Region                            | Specific area (Ghana)                                                | Rock type                                                                        | Likely olivine content                                                       | Practicality for ERW                                                                                                                                                                                  |
|-----------------------------------|----------------------------------------------------------------------|----------------------------------------------------------------------------------|------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Western Region                    | Aketakyi (southern part of the Ashanti Belt)                         | Ultramafic–mafic complex (cumulate dunite, harzburgite, pyroxenite, gabbro) [10] | High: Dunite/harzburgite often > 50 % olivine, possibly up to 90 % in dunite | High potential: very favourable rock type (olivine-rich), reasonably accessible in the southern Ashanti belt; need to assess mining/processing, weathering kinetics, environmental/ tracing aspects.  |
| Western Region (Coastal SW Ghana) | Butre-Axim / Ankobra coast (southern end of Ashanti belt) [11]       | Ultramafic intrusion varying from peridotite, pyroxene/dunite, gabbro/norite     | Likely high: If peridotite/dunite is present, olivine may be >40–80%         | Good potential Coastal setting may aid logistics for deployment, but need to verify extent of dunite/peridotite, and degree of alteration (serpentinization), which may reduce fresh olivine content. |
| Volta Region (Southeastern Ghana) | Adaklu Dahomeyide suture zone ultramafic igneous plutonic rocks [12] | Ultramafic plutonic rocks (pyroxenite, lesser peridotite)                        | Moderate: Pyroxenite dominant means lower olivine (~20-50%)                  | Moderate potential: Some olivine content but less than ideal; structural/metamorphic complexity may affect usability and weathering behaviour.                                                        |



**Figure 1. Samples of rock minerals with high potential for ERW [13] (A) Olivine (B) Basalt (images obtained from geology.com/minerals)**

## Estimated National-Scale Potential

The national potential of ERW in Ghana should be evaluated based on creditable net CO<sub>2</sub> removals rather than theoretical chemical uptake. Creditable removals are influenced by the fraction of applied rock that weathers within defined crediting periods, lifecycle emissions associated with mining, grinding, transport, and spreading, and conservative uncertainty deductions as prescribed by emerging MRV (Monitoring, Reporting, and Verification) standards [14]. This approach ensures that carbon credits generated are robust, verifiable, and aligned with global CDR accounting frameworks.

Using a ceiling scenario of 23 million tonnes of basalt applied annually, corresponding to roughly 1% of Ghana's estimated suitable basalt resources, preliminary analyses indicate a wide range of ERW performance depending on site-specific weathering rates, application practices, and carbon market conditions [15, 16]. For example, assuming conservative credited net-removal factors of 0.05–0.20 tCO<sub>2</sub> per tonne of rock, annual net removals could range from 1.15 to 4.6 million tonnes of CO<sub>2</sub>. When coupled with current international carbon pricing, this translates to potential gross revenues from USD 173 million to over USD 1.6 billion per year, with net profits contingent on logistics, operational costs, and robust MRV verification (Table 2).

**Table 2. Ghana's preliminary indicative national-scale ERW scenarios (23 Mt rock/year)**

| Scenario | Credited Net Removal Factor (tCO <sub>2</sub> / t rock) | Annual Credited Removals (MtCO <sub>2</sub> /yr) | Carbon Price (USD/tCO <sub>2</sub> ) | Annual Gross Revenue (USD) | Indicative Cost (USD/tCO <sub>2</sub> ) | Annual Cost (USD) | Annual Net (USD) |
|----------|---------------------------------------------------------|--------------------------------------------------|--------------------------------------|----------------------------|-----------------------------------------|-------------------|------------------|
| Low      | 0.05                                                    | 1.15                                             | 150                                  | 173 mil                    | 120                                     | 138 mil           | 35 mil           |
| Mid      | 0.1                                                     | 2.3                                              | 250                                  | 575 mil                    | 150                                     | 345 mil           | 230 mil          |
| High     | 0.2                                                     | 4.6                                              | 350                                  | 1.61 bil                   | 180                                     | 828 mil           | 782 mil          |

Unlike short-term avoided-emissions mechanisms such as REDD+, ERW delivers long-lived geochemical carbon sequestration, converting CO<sub>2</sub> into stable carbonate minerals in soils. In addition to climate mitigation, ERW can provide significant co-benefits for agriculture, through soil pH buffering and improved nutrient availability (Ca, Mg, K) leading to potential yield gains on acidic tropical soils.

These co-benefits can strengthen food security, support rural livelihoods, and enhance overall land productivity, making ERW a multi-dimensional climate and development strategy.

Even under conservative assumptions, ERW could deliver removals comparable to or exceeding current forest-based carbon revenues, while offering more durable carbon storage. These estimates remain indicative and should not be interpreted as investment-grade projections. Profitability will depend on targeting high-performance sites, minimizing logistics costs, and achieving robust MRV.

## How ERW Generates Carbon Credits

While there is not yet a single globally harmonized standard for ERW carbon credits, several registries and research consortia have developed provisional methodologies that define how net carbon dioxide removal must be quantified, monitored, and conservatively credited [17-19]. These methodologies require that only net, durable removals are eligible for crediting, after accounting for full lifecycle emissions, measurement uncertainty, and permanence risk buffers.

In practice, creditable removals are not calculated directly from rock chemistry alone. Instead, net CO<sub>2</sub> removal is determined through a combination of field measurements and geochemical mass-balance modeling, typically expressed as:

Credited CO<sub>2</sub> Removal = (Measured or modeled weathering-derived alkalinity export or carbonate formation) – (Lifecycle emissions from mining, grinding, transport, and spreading) – (uncertainty and risk deductions).

Although the theoretical maximum CO<sub>2</sub> uptake of pure olivine is approximately 0.63 tCO<sub>2</sub> per tonne of mineral, actual creditable removals are substantially lower because only a fraction of the applied rock weathers within the crediting period, and not all weathering products can be confidently attributed to permanent carbon storage pathways. Consequently, ERW methodologies apply conservative factors that translate chemical potential into credited net removal per tonne of rock applied, often well below theoretical limits.

For Ghanaian ERW projects, project-specific removal estimates must therefore be derived from detailed mineralogical characterization of local basalt, soil chemistry and hydrological conditions, basalt spreading rates expressed in tonnes per hectare per year (t ha<sup>-1</sup> yr<sup>-1</sup>) and particle size distributions, field measurements of alkalinity and dissolved inorganic carbon fluxes, and site-specific lifecycle emission inventories. These parameters are incorporated into calibrated geochemical models that are validated against field monitoring data, rather than spreadsheet-only calculations based on mineral composition. Only after this validation can conservative crediting factors be established for different regions and cropping systems in Ghana. This underscores the necessity of pilot-scale field trials to determine locally defensible net removal rates and establish MRV protocols before large-scale deployment or revenue projections are considered.

## Local Capacity and National Readiness

Ghana possesses strong foundational scientific and institutional capacity that can support the development of a nationally led ERW programme, particularly in mineral characterization, soil science, agronomy, and environmental monitoring. Universities and research institutions, including KNUST, already maintain laboratories equipped for analyses of rock mineralogy, particle-size distribution, and soil geochemistry which are essential components of ERW site assessment and material suitability screening. However, full carbon-credit verification for ERW extends beyond laboratory measurements and requires field-based hydrological monitoring, geochemical mass-balance analysis, uncertainty quantification, and compliance with international carbon registry methodologies.

These components are not yet standard practice within Ghana's environmental monitoring systems and will require targeted capacity building, instrumentation upgrades, and methodological training. In addition, independent third-party validation and registry approval, typically conducted by internationally accredited bodies will remain necessary to ensure market acceptance of credits, particularly in early project phases. Thus, Ghana is well positioned to lead ERW deployment and data generation domestically, with international expertise serving a supporting role. A phased approach that combines local research leadership with selective international technical collaboration during pilot stages will allow Ghana to build long-term national MRV competence while maintaining credibility with global carbon markets.

## Environmental and Social Considerations

ERW offers potential environmental co-benefits in Ghana, particularly for acidic and nutrient-poor soils, but its large-scale deployment must be evaluated through both agronomic performance and environmental risk frameworks. Small-scale field experiments in Ghana have demonstrated that silicate-rich materials, including locally sourced mining by-products, can increase soil alkalinity and in some cases improve crop productivity, indicating active mineral weathering processes and potential soil fertility benefits [20]. However, increases in soil or porewater alkalinity alone do not constitute confirmation of durable carbon sequestration, as only a fraction of weathering products may ultimately contribute to long-term oceanic or mineral carbon storage pathways.

At national scale, ERW deployment raises several environmental considerations that require systematic assessment, including dust exposure during crushing and spreading, potential mobilization of trace metals, impacts on surface water chemistry through runoff, and the cumulative footprint of expanded quarrying and transport activities [21]. These risks vary substantially by rock type, soil chemistry, hydrology, and farming system, and therefore require site-specific environmental screening rather than generalized national assumptions.

In particular, the use of mine tailings, while potentially cost-effective, demands stringent contamination testing and regulatory oversight due to higher variability in chemical composition [15].

From a social perspective, farmer adoption cannot be assumed based solely on potential yield improvements.

Participation will depend on labor requirements, compatibility with existing fertilizer practices, perceived economic benefit, trust in implementing institutions, and the timing of material delivery relative to cropping cycles. Dedicated extension services, demonstration plots, and farmer compensation mechanisms may be required during early deployment phases to ensure sustained participation and avoid unintended livelihood burdens. Energy use in rock crushing and grinding represents both a major emissions source and a significant cost driver for ERW. While the integration of renewable energy can reduce lifecycle emissions, practical implementation will require capital investment, reliable power availability, and careful siting of processing facilities relative to both quarries and agricultural zones.

## Research Gaps and Data Needs

Despite growing global interest in ERW, there is currently no Ghana-specific field evidence that quantifies net, creditable CO<sub>2</sub> removal attributable to ERW under local soil, climate, and hydrological conditions. To date, estimates have relied primarily on (i) laboratory batch dissolution experiments, (ii) controlled column leaching studies, (iii) geochemical equilibrium and reactive transport modelling, and (iv) theoretical stoichiometric uptake calculations derived from mineral chemistry. While these approaches provide useful mechanistic insights, they cannot determine how much applied material contributes to durable carbon storage pathways under real field conditions within realistic carbon crediting windows. Furthermore, they cannot reliably distinguish ERW-induced carbon signals from background natural silicate weathering in tropical environments such as Ghana. Accordingly, the following critical research gaps remain unresolved:

- What fraction of applied basalt undergoes complete silicate weathering leading to long-lived carbon storage (e.g., dissolved bicarbonate export or secondary carbonate formation), as opposed to remaining unreacted or cycling through short-lived soil carbon pools?
- What is the time-resolved profile of CO<sub>2</sub> removal under Ghanaian climatic and hydrological conditions? Specifically, what proportion of total removal occurs within commercially relevant crediting periods (5–20 years)?
- How can ERW-driven carbon removal signals be quantitatively separated from high natural background weathering rates and biogenic CO<sub>2</sub> fluxes characteristic of tropical systems, without incurring uncertainty deductions that compromise credit eligibility?

Beyond process-level uncertainties, Ghana lacks any integrated, end-to-end assessment of net carbon efficiency, expressed as tonnes of CO<sub>2</sub> credibly removed per tonne of rock applied after full lifecycle emissions are accounted for. Lifecycle components include mining, crushing, transport, field spreading, and monitoring, reporting, and verification (MRV). Energy intensity and logistics are expected to dominate both project emissions and costs; however, these parameters remain unquantified in Ghana, where infrastructure quality, fuel mix, haulage distances, and agricultural deployment models differ markedly from assumptions embedded in global ERW assessments.

A further critical gap concerns economic viability. There is no Ghana-specific cost curve for ERW expressed as cost per credited tonne of CO<sub>2</sub> removed, rather than gross or theoretical uptake. Without such data, ERW cannot be rigorously compared with alternative mitigation or carbon removal options in national climate planning or carbon market strategies.

In addition to carbon accounting uncertainties, agronomic and environmental outcomes remain poorly constrained. Soil response, nutrient release dynamics, pH buffering capacity, trace metal mobilization, and hydrological impacts are likely to vary substantially across Ghana's agro-ecological zones. The Guinea savannah, forest transition, and coastal savannah regions each present distinct soil chemistries and cropping systems, yet no coordinated field trials currently evaluate ERW performance across these zones. Social and operational dimensions also remain unexplored. Farmer acceptance, logistical feasibility, cost-sharing structures, and long-term adoption dynamics in smallholder-dominated systems have not been systematically assessed.

Importantly, no integrated datasets currently link carbon removal performance, crop response, environmental safety, and socio-economic feasibility within the same deployment sites. This fragmentation of evidence represents a fundamental barrier to policy development, MRV framework design, and investment readiness

## **Recommendations Before Scale-Up**

To transition ERW in Ghana from conceptual potential to policy-relevant deployment, the following actions are required before any large-scale implementation:

- Establish coordinated ERW pilot projects across representative agro-ecological zones to directly measure weathering rates, carbon fluxes, soil chemistry evolution, and crop response under real farming conditions.
- Adapt and test emerging ERW MRV methodologies to Ghanaian soils and hydrology, including conservative uncertainty deductions aligned with international carbon market standards, to determine what fraction of removals is credibly creditable.
- Conduct detailed lifecycle assessments covering quarrying, grinding, transport, application, and monitoring, using Ghana's actual energy mix and logistics to determine net carbon efficiency and realistic cost per credited tonne.

- Pair carbon monitoring with systematic assessment of soil health, crop yields, water quality, and trace metal behavior to ensure ERW deployment is agronomically beneficial and environmentally safe.
- Evaluate farmer willingness to participate, required incentives, operational constraints, and the role of extension services, cooperatives, and local governments in supporting deployment.
- Engage early with carbon registries and buyers to test whether Ghana-based ERW projects can meet evolving permanence, additionality, and uncertainty requirements, and under what pricing conditions they become viable.
- Strengthen local technical capacity across universities, regulatory agencies, and extension systems, while establishing coordination between mineral resource governance, agriculture, environmental regulation, and climate finance institutions.

## Conclusion

ERW offers a credible and potentially strategic addition to Ghana's long-term climate mitigation and climate-smart agriculture portfolio, particularly as the country prepares for the growing need for durable carbon dioxide removal beyond conventional emissions-reduction measures. Ghana's geological endowment, extensive agricultural land base, and strong research institutions provide a solid foundation for exploring ERW as a nationally relevant option rather than an imported technological experiment. However, ERW is not yet an off-the-shelf climate solution. Its contribution and relevance to national mitigation targets, agricultural productivity, and economic development will depend on the ability to demonstrate creditable net carbon removal, acceptable costs, and safe environmental performance under Ghanaian conditions. Current evidence from small-scale experiments suggests agronomic potential and active weathering processes, but this does not yet constitute proof of scalable, market-eligible carbon removal or broad farmer adoption.

A phased national development strategy is therefore recommended, beginning with well-designed pilot projects that integrate carbon accounting, lifecycle emissions analysis, agronomic outcomes, and social feasibility at the same deployment sites. This evidence-driven approach will allow policymakers to determine whether ERW can become a cost-effective component of Ghana's carbon management strategy, particularly for offsetting residual emissions in hard-to-abate sectors. If early phases demonstrate credible performance and economic viability, ERW could evolve into a new green industrial value chain linking mining, logistics, agriculture, and climate finance. Achieving this outcome will require coordinated policy frameworks involving environmental regulation, mineral resource governance, agricultural extension systems, and carbon market engagement, rather than reliance on any single sector or institution. With disciplined scaling based on verified field data rather than optimistic projections, Ghana could position itself as a regional leader in evidence-based carbon removal deployment and contribute meaningfully to the global climate goals while supporting domestic development priorities.

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## References

- [1] M. E. Kelland et al., "Increased yield and CO<sub>2</sub> sequestration potential with the C<sub>4</sub> cereal *Sorghum bicolor* cultivated in basaltic rock dust-amended agricultural soil," *Global Change Biology*, vol. 26, no. 6, pp. 3658-3676, 2020/06/01 2020, doi: <https://doi.org/10.1111/gcb.15089>.
- [2] K. Skov et al., "Initial agronomic benefits of enhanced weathering using basalt: A study of spring oat in a temperate climate," *PLOS ONE*, vol. 19, no. 3, p. e0295031, 2024, doi: 10.1371/journal.pone.0295031.
- [3] M. E. Kelland et al., "Increased yield and CO<sub>2</sub> sequestration potential with the C<sub>4</sub> cereal *Sorghum bicolor* cultivated in basaltic rock dust-amended agricultural soil," *Global change biology*, vol. 26, no. 6, pp. 3658-3676, 2020.
- [4] J. B. Richardson, "Basalt Rock Dust Amendment on Soil Health Properties and Inorganic Nutrients—Laboratory and Field Study at Two Organic Farm Soils in New England, USA," *Agriculture*, vol. 15, no. 1, p. 52doi: 10.3390/agriculture15010052.
- [5] O.-S. Grace and A. Richard Kwasi, "Acid Drainage Potential of Rocks in South-Western Ghana," *International Journal of Environmental Protection and Policy*, vol. 7, no. 1, pp. 9-16, 2019, doi: 10.11648/j.ijepp.20190701.12.
- [6] J. Streffer, T. Amann, N. Bauer, E. Kriegler, and J. Hartmann, "Potential and costs of carbon dioxide removal by enhanced weathering of rocks," *Environmental Research Letters*, vol. 13, no. 3, p. 034010, 2018/03/05 2018, doi: 10.1088/1748-9326/aaa9c4.
- [7] T. Linke et al., "The geochemical evolution of basalt Enhanced Rock Weathering systems quantified from a natural analogue," *Geochim Cosmochim Acta*, vol. 370, pp. 66-77, 2024/04/01/ 2024, doi: <https://doi.org/10.1016/j.gca.2024.02.005>.
- [8] P. Renforth, "The potential of enhanced weathering in the UK," *Int J Greenh Gas Con*, vol. 10, pp. 229-243, 2012/09/01/ 2012, doi: <https://doi.org/10.1016/j.ijggc.2012.06.011>.
- [9] T. Schlüter, *Geological atlas of Africa: with notes on stratigraphy, tectonics, economic geology, geohazards and geosites of each country*. Springer, 2006.
- [10] S. B. Dampare et al., "Ultramafic–mafic and granitoids supra-subduction magmatism in the southern Ashanti volcanic belt, Ghana: Evidence from geochemistry and Nd isotopes," *Geological Journal*, vol. 55, no. 4, pp. 2495-2531, 2020/04/01 2020, doi: <https://doi.org/10.1002/gj.3512>.
- [11] C. B. Boye and E. B. Fiadonu, "Lithological effects on rocky coastline stability," *Heliyon*, vol. 6, no. 3, p. e03539, 2020/03/01/ 2020, doi: <https://doi.org/10.1016/j.heliyon.2020.e03539>.
- [12] I. AMPONSAH, "HIGH-PRESSURE GRANULITES AND ECLOGITES OF THE DAHOMEYIDE SUTURE ZONE (ADAKLU, SOUTHEASTERN GHANA): PETROGENETIC EVOLUTION AND TECTONIC IMPLICATIONS," 2021. [Online]. Available: <https://afribary.com/works/high-pressure-granulites-and-eclogites-of-the-dahomeyide-suture-zone-adaklu-southeastern-ghana-petrogenetic-evolution-and-tectonic-implications>

- [13] P. M. Nudé et al., "Petrography and chemical evidence for multi-stage emplacement of western Buem volcanic rocks in the Dahomeyide orogenic belt, southeastern Ghana, West Africa," *Journal of African Earth Sciences*, vol. 112, pp. 314-327, 2015/12/01/ 2015, doi: <https://doi.org/10.1016/j.jafrearsci.2015.09.019>.
- [14] I. M. Power, V. N. J. Hatten, M. Guo, Z. R. Schaffer, K. Rausis, and H. Klyn-Hesselink, "Are enhanced rock weathering rates overestimated? A few geochemical and mineralogical pitfalls," (in English), *Frontiers in Climate, Perspective* vol. Volume 6 - 2024, 2025-January-13 2025, doi: 10.3389/fclim.2024.1510747.
- [15] R. M. Eufrasio et al., "Environmental and health impacts of atmospheric CO<sub>2</sub> removal by enhanced rock weathering depend on nations' energy mix," *Communications Earth & Environment*, vol. 3, no. 1, p. 106, 2022/05/05 2022, doi: 10.1038/s43247-022-00436-3.
- [16] G. O. Kesse, "The mineral and rock resources of Ghana," 1984.
- [17] M. O. Clarkson et al., "A review of measurement for quantification of carbon dioxide removal by enhanced weathering in soil," (in English), *Frontiers in Climate, Review* vol. Volume 6 - 2024, 2024-June-19 2024, doi: 10.3389/fclim.2024.1345224.
- [18] L. Mercer, J. Burke, and S. Rodway-Dyer, "Towards improved cost estimates for monitoring, reporting and verification of carbon dioxide removal," 2024.
- [19] S. M. Smith et al., "The state of carbon dioxide removal: a global, independent scientific assessment of carbon dioxide removal," 2024.
- [20] E. Oppong Danso, C. Dietzen, E. Arthur, and M. T. Rosing, "Enduring increases in maize yield are a co-benefit of enhanced weathering of Greenlandic glacial rock flour in Ghana," *Nutrient Cycling in Agroecosystems*, vol. 131, no. 3, pp. 761-772, 2025/12/01 2025, doi: 10.1007/s10705-025-10442-4.
- [21] C. R. Levy et al., "Enhanced Rock Weathering for Carbon Removal-Monitoring and Mitigating Potential Environmental Impacts on Agricultural Land," (in eng), *Environ Sci Technol*, vol. 58, no. 39, pp. 17215-17226, Oct 1 2024, doi: 10.1021/acs.est.4c02368.