

CME Submission to "ERF method development priorities for 2022"

Submission online via the consultation hub at <https://consult.industry.gov.au/erf-method-development-priorities-for-2022>

1. Title:

Mineral Carbonation

2. Briefly describe the proposed emissions reduction activity.

Include a detailed, clear and well defined description to enable a thorough understanding of the activity. Include the type of user group who would be likely to undertake the proposed emissions reduction activity.

Mineral carbonation (also known as "carbon mineralization") is "the process by which carbon dioxide becomes a solid mineral, such as a carbonate. It is a chemical reaction that happens when certain rocks are exposed to carbon dioxide. The biggest advantage of carbon mineralization is that the carbon cannot escape back to the atmosphere. It happens naturally, but the process can be sped up artificially." (United States Geological Survey, www.usgs.gov)

This response is provided as a general response for industry broadly rather than a project / location specific response due to the potential application across the resources sector.

This proposed emissions reduction activity would focus on artificially speeding up the natural carbonation process (through increasing the surface area and / or the availability of CO₂) that occurs with mineral wastes to promote additional removal (sequestering) of CO₂. Given the significance of the resources sector in WA and Australia more broadly, there is significant abatement opportunity from mineral carbonation.

It should be noted mineral carbonation is a chemical process that results in the permanent removal of CO₂ (conversion to carbonates) rather than a temporary (even if multi-year) removal of CO₂.

The user group that would be likely to undertake the proposed emissions reduction activity would be the resources sector and potentially (through Abandoned Mine Programmes) State and Territory Governments as managers of historically abandoned mine features. There is also potential for the production of "green" materials following from mineral carbonation including in building materials and other applications.

A review of mineral carbonation opportunities is available in "Opportunities for Mineral Carbonation in Australia's Mining Industry" - Mehdi Azadi, Mansour Edraki, Faezeh Farhang and Jiwhan Ahn (https://www.mdpi.com/2071-1050/11/5/1250?type=check_update&version=1)

The IPCC's chapter on mineral carbonation in the "Special Report on Carbon dioxide Capture and Storage" is available here: https://www.ipcc.ch/site/assets/uploads/2018/03/srccs_chapter7-1.pdf

3. Is the emissions reduction activity currently business-as-usual?

Include an assessment as to the whether the activity is considered business as usual for the sector i.e. to what extent is it being adopted or current standard practice. Your response should address why this activity would not occur in the absence of the ERF?

The natural process of mineral carbonation that occurs through deposition of tailings already occurs and would need to be excluded by the method. The method should focus on incentivising the additional (artificial) mineral carbonation that would not otherwise occur in the absence of an ERF method. This would involve increasing the surface area available for the carbonation process or increasing the availability of carbon dioxide or both with only the additional sequestration to be covered by the method.

Mineral carbonation has been widely studied globally, particularly in relation to bauxite residues, however we are unaware of any current industrial scale projects in Australia that are artificially accelerating mineral carbonation for CO₂ sequestering - it is not common or current standard practice.

4. Briefly outline how the activity has been demonstrated to reduce emissions.

Your response must include evidence to support claims that the activity reduces greenhouse gas emissions or sequesters carbon for example, through peer reviewed scientific publications that reflect Australian conditions.

Your response must also consider the extent to which the emissions reductions will be permanent i.e. identify any circumstances under which the reductions may be reversed. This applies to activities that sequester emissions and/or avoid emissions.

Please refer to the IPCC's Special Report on Carbon dioxide Capture and Storage (available here:

https://www.ipcc.ch/site/assets/uploads/2018/03/srccs_chapter7-1.pdf)

This states:

* "this method of storage is highly verifiable and unquestionably permanent"

* "Once the carbon has been stored through mineral carbonation, there are virtually no emissions of CO₂ due to leakage. To the extent that weathering at the disposal site occurs and leaches out magnesium carbonate from the carbonation products, additional CO₂ would be bound in the transformation of solid magnesium carbonate to dissolved magnesium bicarbonate (Lackner, 2002). It can therefore be concluded that the fraction of carbon dioxide stored through mineral carbonation that is retained after 1000 years is virtually certain to be 100%."

Further information about mineral carbonation is also available from CSIRO including through their recently published CO₂ Utilisation Roadmap available here: <https://www.csiro.au/en/work-with-us/services/consultancy-strategic-advice-services/CSIRO-futures/Futures-reports/CO2-Utilisation-Roadmap>.

Additionally, and specific to the Australian context, please refer to "Opportunities for Mineral Carbonation in Australia's Mining Industry" - Mehdi Azadi, Mansour Edraki, Faezeh Farhang and Jiwhan Ahn (https://www.mdpi.com/2071-1050/11/5/1250?type=check_update&version=1)

Please refer to the IPCC's Special Report on Carbon dioxide Capture and Storage (available here:

https://www.ipcc.ch/site/assets/uploads/2018/03/srccs_chapter7-1.pdf)

5. What is the likely uptake of the emissions reduction activity and the likely volume of abatement?

Your response should include an assessment of:

The likely uptake of the emissions reduction activity - This may include consideration of the costs of implementing the activity and market prices for Australian carbon credit units, and the level of business support required for the activity.

The likely volume of abatement from the activity. Your response should consider project emissions (emissions that occur as a result of the activity) which should be deducted when estimating net abatement.

In providing your response, please include assumptions used to determine likely uptake and volume of abatement.

According to Bullock et al (2021): "all deposit types, notably mafic and ultramafic rock-hosted operations and high tonnage Cu-hosting deposits, have the potential to capture ~1.1–4.5 Gt CO₂ annually, between 31 and 125% of the industry's primary emissions". (Global Carbon Dioxide Removal Potential of Waste Materials From Metal and Diamond Mining, <https://doi.org/10.3389/fclim.2021.694175>)

In the context of the Australian resources sector, tailings are already being produced and hence this method should focus on unlocking the additional potential for CO₂ sequestering through incentivising resource sector companies to implement options that increase CO₂ availability and / or surface area in order to artificially increase CO₂ sequestration beyond that which would naturally occur.

Creating this incentive is important for 2 reasons: 1. it would provide formal policy recognition and 2. there will be engineering, design, operational and maintenance costs associated with artificially increasing the CO₂ sequestering -

providing an ERF method for this would incentivise that abatement to still proceed and provide a means for abatement recognition and offsetting costs.

The total volume of abatement would be contingent on uptake however, depending on the specific geology and other local conditions, it would be possible for some resource sector companies to abate entirely their emissions with opportunities to abate in excess of their total emissions (and therefore generate additional ACCUs).

In WA, it is anticipated that some nickel, diamond and bauxite operations would be the most likely contenders based on geology. Initial discussions with the Geological Survey of WA have indicated support for this method as a permanent sequestering option for the WA resources sector and have noted that WA has favourable geology for carbon mineralisation. Additionally, the Department of Mines, Industry Regulation and Safety (DMIRS) indicates WA has over 800 tailings dams.

6. Is the activity using technology or practice that is proven and commercially viable?

Please include evidence to support this.

For activities that require more technological development, outline any research, science or development required for the activity before it can be made into an ERF method and if applicable, who is undertaking this work.

For activities that are not yet commercially available, please provide an explanation as to what is required to make this activity commercially available. Include if the work is already resourced, by who, and expected timing for commercialisation. Your answer should include the likely costs for businesses to implement the activity.

In your response, you may also outline if you see any benefit to trialling the activity as a pilot method and what questions/issues would be resolved by a trial.

The technology needed is available however this will likely only be adopted if there is formal policy recognition for carbon mineralisation so there can be crediting or generation of ACCUs for the abatement that is additional to the abatement that would occur naturally through tailings deposition. It is noted that the prices of ACCUs have increased recently and that in the near to mid-term, there is expected to be increased demand for abatement in Australia / Western Australia.

Modelling in the CSIRO CO₂ Utilisation Roadmap (2021) identifies that mineral carbonation can be cost competitive although many factors (such as location, geology etc) will affect this in any specific instance. In some circumstances, there will be potential for production of value-added products that may improve the economics of mineral carbonation.

In addition to the previously mentioned papers and research, a review of mineral carbonation indicated a cost per tonne CO₂ (2018) of between \$17-300 ("Integrated Mineral Carbonation of Ultramafic Mine Deposits—A Review" Jiajie Li et al, <https://www.mdpi.com/2075-163X/8/4/147/html>)

7. Could the emissions reduction activity cause adverse environmental, economic or social impacts?

If so, please identify them.

Include information on potential adverse impacts on society, the environment or the economy, and how this question has been considered and addressed. If there are adverse impacts, what mitigation measures could be implemented to address the impacts?

If mineral carbonation of tailings and mineral waste streams is applied at existing (approved) mining operations, the environmental impacts (such as land clearing) will already be covered (occurring) as part of the mining operation.

If there is opportunity for value-add products to be generated from the mineral carbonation, there is potential to reduce overall environmental impacts by 1. reducing mineral waste volumes and storage issues, 2. displacing the need for other (raw) natural resource extraction (eg: for building and construction material and basic raw materials) and 3. sequestering additional carbon by artificially elevating the natural mineral carbonation process.

Tailings dam and waste rock dump stability considerations will need to be incorporated as part of any proposal for mineral carbonation proposals (noting tailings dam proposals are more likely to be economically viable). Research indicates tailings stability is improved through this process which may then present an additional societal benefit and may have added benefits for mine rehabilitation, particularly in relation to bauxite residues (due to pH).

In the longer term, mineral carbonation may present opportunities for State and Territory Governments through their historic abandoned mine programmes.

8. Are you aware of any other programs that could support the emissions reduction activity?

Is there another mechanism or government or non-government program that may support the activity?

Are there any policies or programs this activity may complement or link to?

No programmes identified specific for mineral carbonation however mineral carbonation is aligned well with the Australian Government's Technology Investment Roadmap given identification of carbon capture and storage as one of 5 key priority areas.

The Carbon Capture Use and Storage Development Fund may be relevant (<https://www.minister.industry.gov.au/ministers/taylor/media-releases/accelerating-carbon-capture-technologies>).

Given the relevance of the resources sector to the WA and Australian economy, adoption of CO2 sequestration options that integrate with and are viable within the resources sector offers a strong complement to the existing Australian economic base and its transition to net zero emissions.

The WA Government has also initiated a "Net Zero Emissions Mining" Challenge through its WA Climate Policy - mineral carbonation would complement this.

9. How does the proposed emissions reduction activity align with broader government priorities and/or provide co-benefits?

What government priorities does your idea relate to?

For example, how does the proposed activity align with the Low Emissions Technology Statement under the Technology Investment Roadmap? Are there additional benefits beyond emissions reduction from the activity?

Please see above - of most relevance is the Technology Investment Roadmap (<https://www.industry.gov.au/data-and-publications/technology-investment-roadmap-first-low-emissions-technology-statement-2020/technology-investment-roadmap>).

Additional benefits as mentioned above include the potential (in some instances) for value-added products and benefits for tailings stability (and ultimately mine closure) and reduction in mineral waste at mine sites.

10. Could the emissions reduction activity be promoted more efficiently through other measures?

If so, please identify them.

Is there another ERF method, another mechanism or government program better suited to supporting the activity? What are the policies and programs this activity would complement and link to?

Mineral carbonation is not currently recognised as an emissions reduction activity by the Carbon Credits (Carbon Farming Initiative) Act 2011.

The Carbon Capture Use and Storage Development Fund may be relevant (<https://www.minister.industry.gov.au/ministers/taylor/media-releases/accelerating-carbon-capture-technologies>).