The possibilities of *Ex-Situ* Mineral Storage of CO_2 in Greece

OPEN UNIVERSITY OF CYPRUS

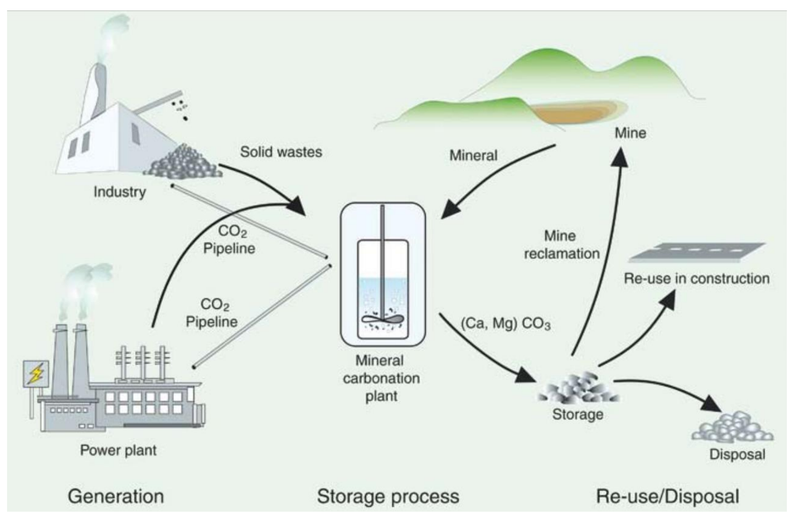
Chioti Marialena*, Zorpas Antonis and Stylianou Marinos

Faculty of Pure and Applied Sciences, Environmental Conservation and Management Programme, Open University of Cyprus, P.O.Box 12794, 2252, Latsia, Nicosia, Cyprus

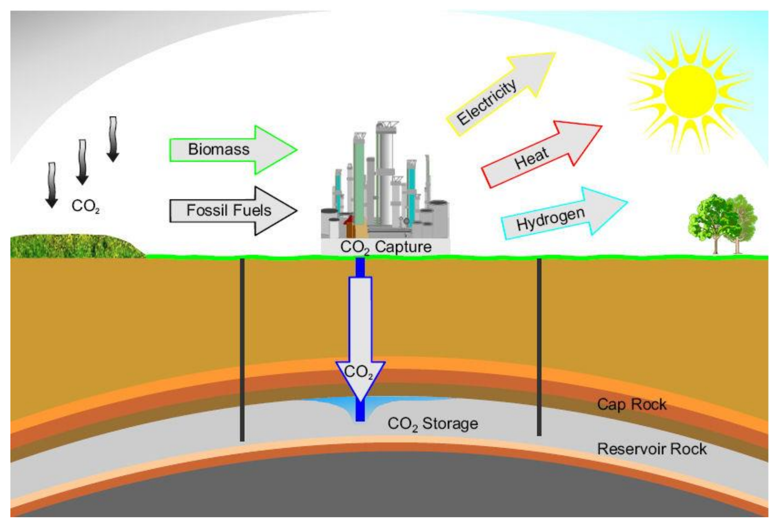
Corresponding author:* **e-mail address: eleni.chioti@st.ouc.ac.cy

Introduction:

- This bibliographic study is focused on CO_2 storage possibilities in outcrop minerals through ex-situ methods.
- Carbon storage is an effective method for long-term storage of carbon dioxide into surface or subsurface rocks and minerals to combat climate change.
- At a large-scale, it can provide a viable solution to effectively lower GHGs emissions.
- Generally CO_2 storage is accomplished by two main methods:
  - ✓ **Surface process (*Ex-situ*)**
  - ✓ **Subsurface Injection (*In-situ*)**
- This CO_2 storage technique is accomplished through mineral carbonation. It is an attractive technology in which CO_2 chemically reacts with calcium, sodium, and magnesium containing materials to precipitate stable and environmentally harmless minerals, usually carbonates.



(Mazzoti et al, 2015)



(CCTNE-Climate change the new economy, 2017)

Figure 1 and 2. Surface Ex-situ process (left) and Subsurface In-situ Injection process (right).

Materials and methods:

- There is a wide range of materials that can be used for mineral carbonation (Fig 3), divided into two main categories:
  - ✓ Naturally occurring formations such as:
    - ultramafic rocks (olivine, serpentine and wollastonite) and
    - zeolites
  - ✓ Wastes comprised of Mg/Ca-rich materials, such as:
    - fly ash,
    - iron and steel slags, and
    - ultramafic mine wastes (Li et al, 2018)
    - other wastes (red mud)
  - Greece provides a variety of mine waste materials suitable for surface CO_2 storage, but this potential is yet underexplored.
- The present bibliographic study is focused on CO_2 sequestration by red mud, a solid residue produced during the alumina extraction.

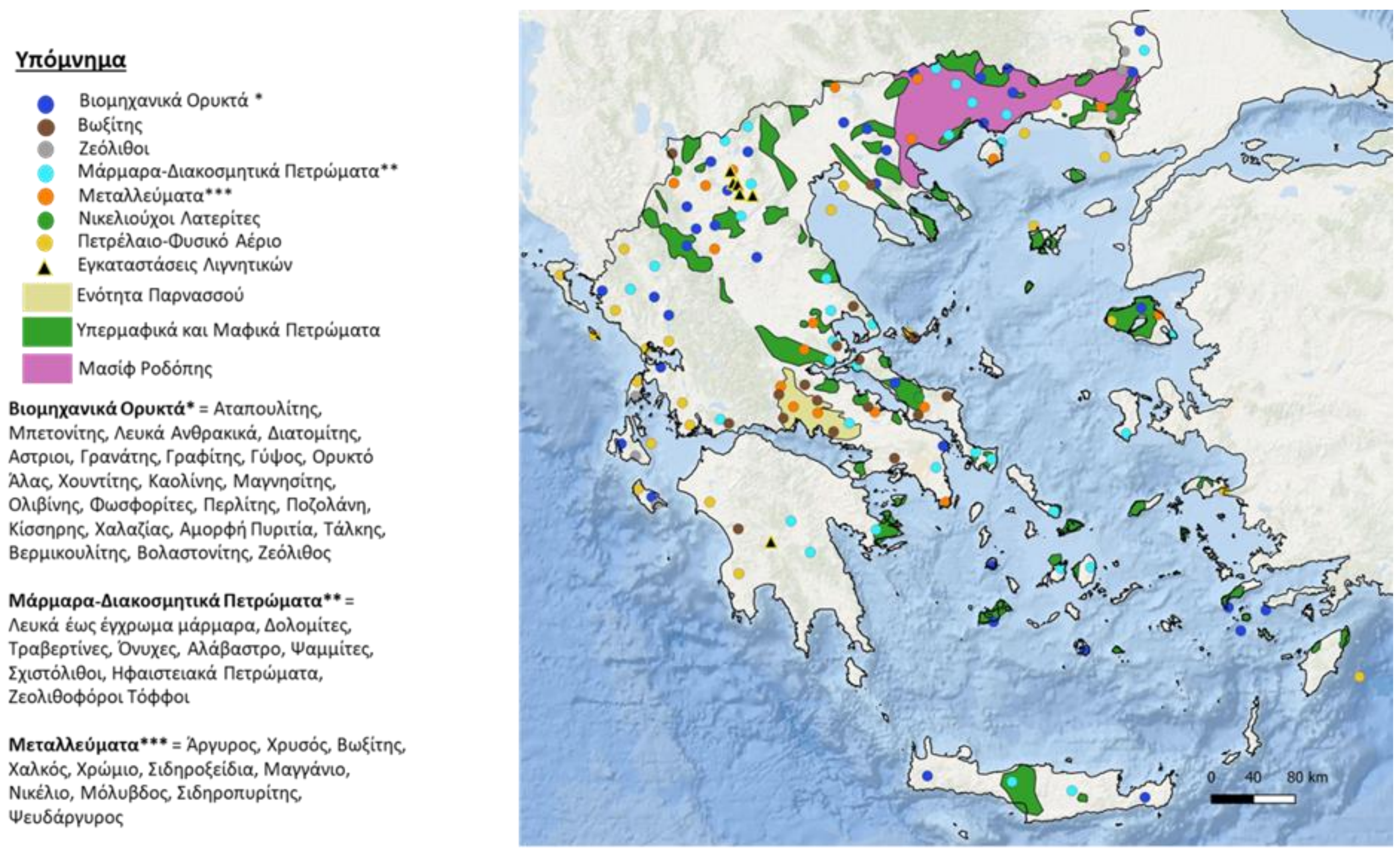


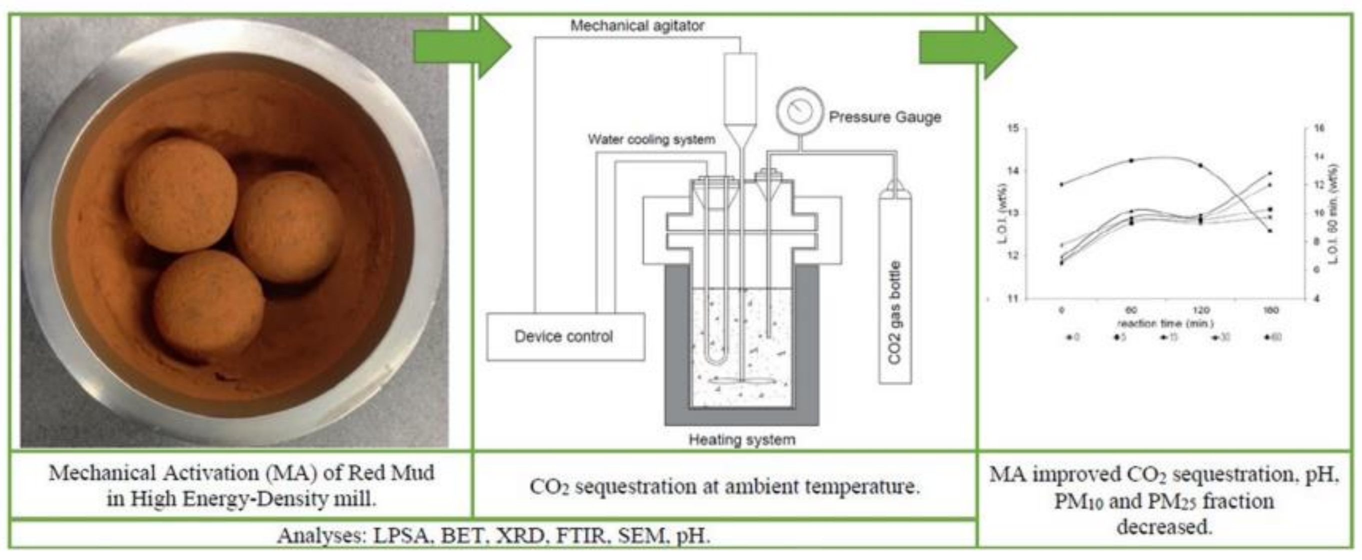
Figure 3. Map demonstrating possible material for CO_2 mineral carbonation

Results:

Table 1. Main properties and carbonation conversions of waste materials demonstrating their CO_2 storage effectiveness.

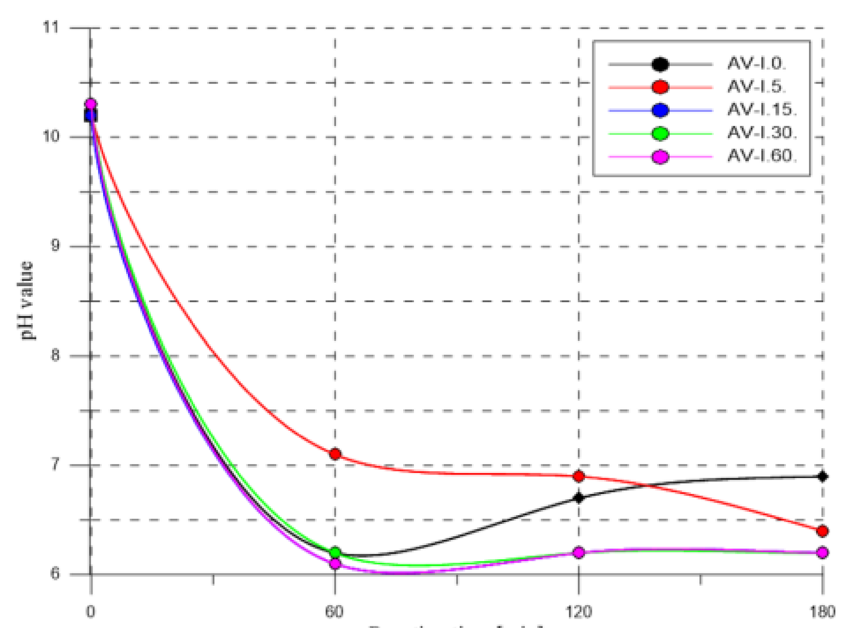
Material	CaO (%)	MgO (%)	Theoretical maximum CO_2 uptake (tCO_2)	Experimental CO_2 Uptake (ECO%)
Fuel Combustion Ashes	1.3-10	1-3	6-9	2.6
Lignite Fly Ash	27.5	6.5	43	23
Ni Tailings	3.4	21-40	43	29
Red Mud	2-7	<1	7-19	4.15-7.2

(Data acquired from Sanna et al, 2014)



(Mucsi et al, 2021)

Figure 4. Mechanical activation of Red Mud to enhance CO_2 sequestration of red mud as shown by Mucsi et al, 2021.



(Mucsi et al, 2021)

Figure 5. Variation of pH as function of grinding time and reaction time that proved the CO_2 sequestration of red mud as shown by Mucsi et al, 2021.

Conclusions:

- Therefore, establishing CO_2 storage as a technique will:
  - ❑ Low CO_2 storage through mineral carbonation
  - ❑ Neutralize the waste
  - ❑ Low contribution in minimizing the Greenhouse Gas Emissions (GNG) emissions

References

Barescut, J. C., Gariel, J. C., Péres, J. M., Papatheodorou, G., Papaefthymiou, H., Maratou, A., & Ferentinos, G. (2005). Natural radionuclides in bauxitic tailings (red-mud) in the Gulf of Corinth, Greece. *Radioprotection*, *40*(S1), S549-S555.
Charalampides, G., Arvanitidis, N., Vatalis, K. I., & Platias, S. (2013). Sustainability perspectives in Greece as reflected by mineral deposits exploitation. *Procedia Economics and Finance*, *5*, 143-151.
Climate Change The New Economy, 2022. *New report stresses importance of CCS for hitting climate change targets - Climate Change The New Economy*. [online] Available at: <https://climatechange-theneweconomy.com/new-report-stresses-importance-ccs-hitting-climate-change-targets/>
Greek extractive industry international environment profile – prospects.2015, Ministry of Environment, Energy & Climate Change.
Li, J., Hitch, M., Power, I. M., & Pan, Y. (2018). Integrated mineral carbonation of ultramafic mine deposits—a review. Minerals, 8(4), 147
Mazzotti, M., Abanades, J. C., Allam, R., Lackner, K. S., Meunier, F., Rubin, E., ... & Zevenhoven, R. (2005). Mineral carbonation and industrial uses of carbon dioxide. In *IPCC special report on carbon dioxide capture and storage*. Cambridge University Press.
MINING GREECE.com. , *MINING GREECE BAUXITE*. Available at: <https://www.miningreece.com/mining-greece/minerals/bauxite/> Greek Extractive Industry. 2015.
Mucsi, G., Halyag, N., Kurusta, T., & Kristály, F. (2021). Control of Carbon Dioxide Sequestration by Mechanical Activation of Red Mud. *Waste and Biomass Valorization*, 1-15.
Sanna, A., Uibu, M., Caramanna, G., Kuusik, R., & Maroto-Valer, M. M. (2014). A review of mineral carbonation technologies to sequester CO_2. *Chemical Society Reviews*, *43*(23), 8049-8080.
Tsirambides, A., & Filippidis, A. (2012). Greece seeks mineral lifeboat. *Industrial Minerals(London)*, (532).
Kaldellis, J. K., Zafirakis, D., & Kondili, E. (2009). Contribution of lignite in the Greek electricity generation: Review and future prospects. *Fuel*, *88*(3), 475-489.
Kasmaeeyazdi, S., Mandanici, E., Balomenos, E., Tinti, F., Bonduà, S., & Bruno, R. (2021). Mapping of Aluminum Concentration in Bauxite Mining Residues Using Sentinel-2 Imagery. *Remote Sensing*, *13*(8), 1517.

CORFU 2022
9th International Conference on Sustainable Solid Waste Management, 15-18 June 2022