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ARTICLE

Weathering of Wood and Rocks and the Role of Coating in Protection

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ABSTRACT

This article explores the effect of weathering on the degradation of wood and rocks and discusses its prevention strategies and safety aspects. Weathering, including natural, enhanced, accelerated, silicates, polymer degradation and erosion is discussed in this article. Rocks weather naturally very slowly and gradually. Minerals weathering and silica-rich layer formation during single-stage and two-stage carbonation like serpentinization of rocks are discussed. A substantial amount of work has been performed for polymeric coatings globally to extend the life of coating surfaces. The ideal coating system would combine the advantages of performance offered by solvent-based coatings with the advantages offered by water-based coatings in the areas of environmental protection, health and safety. Weathering prevention will stop the wastage of materials.

Keywords: Weathering; Climate; Polymer coating; Environmental protection

1. Introduction

Global warming has increased as per Climate Panel reports [1]. Due to global warming, Antarctic Lake has disappeared from glaciers in just 3 days [2]. It is important to limit global warming below the 1.5 °C target [3]. 2 °C warming can release billions

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of tons of soil carbon putting the atmosphere in more trouble [4]. Carbon capture technology can stop global warming [5]. Mineral carbonation is a leading technology for storing carbon dioxide. However, different rocks and minerals are being weathered naturally making their utilization impossible as weathered materials are not reactive due to silica-rich layers formation on their surfaces. Similarly wood and other materials also deteriorate with the passage of time. Surfaces of different materials are protected using polymeric coatings. There is a sizable global market for polymeric coatings, which come in solvent-based or water-based formulations. The use of water or volatile organic compounds as the bulk solvent carrier is a key distinction between the coating types. Both coating kinds are meant to protect surfaces like metal infrastructure, automobiles, or the interior and external surfaces of buildings, despite their variances. The protection provided by the coating extends the life of these items, frequently significantly. The longer lifespan of the protected structures reduces the need for replacement regularly, lowering the overall carbon footprint and the long-term environmental impact [6]. As long as their respective drawbacks are eliminated, the ideal coating system would combine the performance benefits of solvent-based coatings with the environmental, health, and safety benefits of water-based coatings.

2. Previous studies

Table 1 covers previous studies on weathering of wood and rocks. Scopus search was used for articles collection covering previous studies. The term "studies on weathering of wood and rocks" was used for the literature search.

3. Weathering types

Natural weathering, physical weathering, chemical weathering, oceanic weathering, enhanced weathering, mineral weathering, terrestrial weathering, and silicate weathering are different types of weathering. Few negative emission technologies may be workable [16]. However, no technology is mature enough at the moment or applicable for a commercial scale except geological storage but released CO_2 estimation using ALOHA software [17] must be performed. **Figure 1** shows the CO_2 drawdown of different minerals and rocks [16]. Anorthite has maximum CO_2 drawdown among various minerals and rocks shown in **Figure 1** [16].

Table 1. Studies on weathering of wood and rocks.

Year	Key findings	Reference
2008	Longer exposure time increased the degree of color change (and lightness) on weathered WPC surfaces.	[7]
2009	Chemical modification of wood surfaces with chromic acid is remarkably effective at photo stabilizing wood.	[8]
2013	Protection of wood by plants is done by the use of natural substances i.e., Tannins. Samples which are treated by Tannin show higher resistance against discolouration. PCA revealed that the aromatic component of wood is mainly degraded by weathering.	[9]
2017	Prolonged weathering changed the top surfaces of all tropical woods. The change in macroscopic and color characteristics of wood due to weathering has a connection with changes in its molecular and anatomical structure.	[10]
2019	Artificial weathering caused color change which is evident after 28 hours.	[11]
2020	Three months of natural weathering cause lignin degradation for all species and it is proved by FTIR spectra.	[12]
2020	Accelerated weathering tests have been used not only to evaluate the effectiveness of varnishes and paints.	[13]
2021	Biological durability of specie are enhanced by thermal treatment but it did not protect wood when it was exposed outdoors.	[14]
2021	Basalt is an abundant rock resource, which reacts with CO_2 and removes it from the atmosphere.	[15]

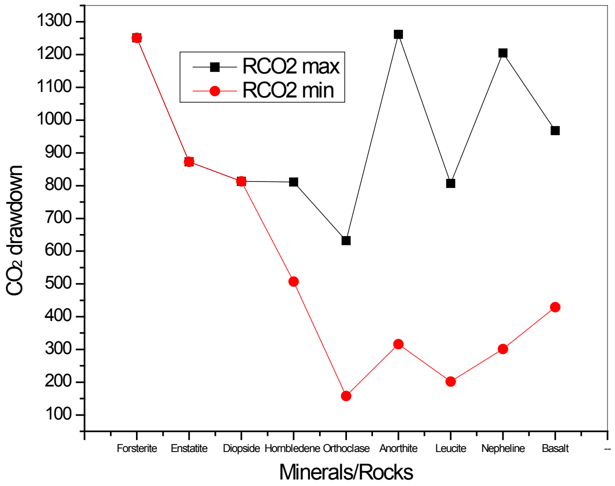


Figure 1. CO_2 drawdown for different minerals and rocks.

3.1 Natural weathering

The weathering of wood, furniture, stones, rocks and minerals is natural weathering. Few paints and varnishes are applied to reduce wear and tear on wooden furniture. However, plastic furniture is a bit safer as it wears less compared to wooden furniture, especially plastic chairs. Rocks hidden beneath water e.g. rocks below lakes are exposed to water and wear and tear may be affecting aquatic life. Aquatic life is important, it can be saved using pollution reduction. Greenhouse gas mitigation technologies are being used for pollution reduction [17–41]. Developing and underdeveloped countries can use coal to mitigate energy demands and gaps for a period until renewables are attained/adopted [42]. Renewable energy resources are also extensively used [43]. Wood degradation has formed coal deposits. FTIR studies revealed that acetyl groups and lignin degraded with increasing weathering period while carbohydrates modified slightly. Characteristic lignin peak at 1500–1510 cm $^{-1}$ was significantly decreased after the 63rd day for most of the species [12]. **Figure 2** is generated using the intensity ratio of lignin/cellulose [12]. Decreased intensity for the 1740–1720 cm^{-1} band belongs to the stretching of acetyl and carboxyl acid (hemicelluloses). The situation is valid for all species mostly after 78 h as proved by intensity analysis shown in **Figure 2**. Significant research in multiple countries has been performed about a variety of wood species. Lignin transformation into quinones is interesting [12,44–46]. Surface roughness changes were observed. FTIR spectra show changes in absorbance, probably due to wood dryness with the passage of time.

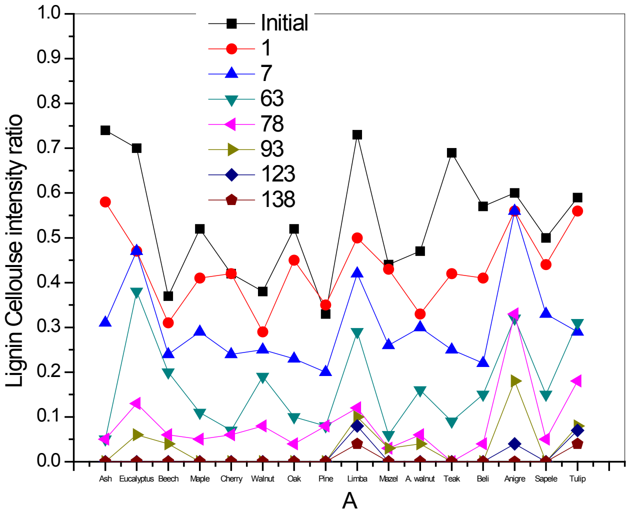


Figure 2. Intensity ratio of lignin/cellulose.

In recent years, there has been a rise of interest in CO_2 switchable polymers, with the property changes being exploited to switch polymer solubility, adjust the surface charge and colloidal stability of polymer nanoparticles, and build new polymeric designs [47–49]. New and interesting carbon dioxide triggers have been developed for stimuli-responsive polymers and other materials whose characteristics vary in response to the application or removal of a trigger [50]. When certain functional groups, such as amines, on a small molecule or polymer go from their neutral to charged state or otherwise, this causes a shift in the material's overall properties (**Figure 3**) [51]. Polymeric materials use has significantly increased [52].

According to previous research on coatings, polyurethane has long been one of the most popular options due to its excellent which includes mechanical, flexibility and elastic strength along with application-wide abrasion resistance, hardness, and weather resistance [53,54]. In prior work, five-membered cyclocarbonate was synthesized by cycloaddition reaction from CO_2 and 1,4-butanediol diglycidyl ether and reacted with excessive diamine [53]. The novel alcohol amine, a chain extender for polyurethane

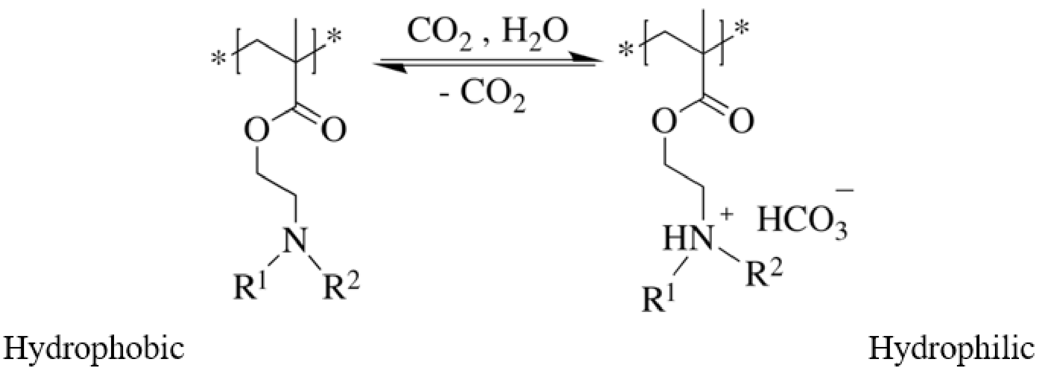


Figure 3. Hydrophobic polymeric amine conversion to hydrophilic state in the presence of CO_2 and water.

coatings, was structurally characterized. New chain extender-based polyurethane coatings showed good mechanical strength and water, salt, and solvent resistance. The polyurethane molecule's hydroxyl group is responsible for the coatings' distinctive performance. Hydrogen bonding increased polyurethane coating cohesiveness and blocked solvents.

3.2 Physical weathering

Water rock interaction, water wood interaction, water cement interaction and water interaction with any solid must be kept minimum. Corrosion can be prevented by reducing water contact with solid materials. Erosion damages materials more quickly e.g. erosion of pump impeller blades or erosion of liners used inside reactors for mineral carbonation or erosion/corrosion of reactors themselves.

3.3 Chemical weathering

Chemicals especially acids can corrode/erode metallic parts. The same is true for bases especially strong bases, they even can burn skin similar to acids. Some acids or some bases are more dangerous e.g. HNO_3 is a strong, oxidizing and toxic chemical and releases very unpleasant and toxic vapors when kept open. Pyrophorus is a different class of chemicals, that catch fire in the presence of air and preferably be stored under a vacuum. H_2SO_4, HFO or HF are also dangerous. Potash is also dangerous, hence kept underwater for safety purposes. Sodium and potassium metals also pose safety hazards. Flammable gases released (methane, ethane etc.) can catch ignition and explode. Chemical inhalation may include symptoms of irritation, nausea, vomiting and diarrhea. Grinding the minerals will produce dust which must be kept below 15 mg/m^3. Mandatory PPEs including safety hats, safety shoes and safety goggles must be worn. The PPEs list is provided in **Table 2**. If chemicals fall on the skin or the eyes, 15-minute washing is recommended.

Toxic ammonia vapors may spread from industrial settings; hence ALOHA software is useful in detecting vapors concentrations present in nearby cities, towns, villages, schools, parks, colonies or roads or train rails [17,55]. ALOHA will give values in AEGL-1, AEGL-2 and AEGL-3. Similar studies can be performed for possible CO_2 releases from geological storage facilities. Acetone fumes have ignited, the same can happen with ether or other flammable vapors. Incident reporting is important [39,40,56]. NFPA diamond protects humans from fire incidents and is best used by firefighters. Safety is everyone's responsibility. A sulfuric acid spill may be taken as an emergency depending on the amount released, in such a case, it's better to gather at the assembly point, the same is true for industry or academic institutes. Lighter ammonia will rise and heavier chlorine stay at the bottom, lighter and heavier gases will follow the same trend. MSDS/SDS provide detailed information and warn humans of forthcoming risks. Small and large chemical spills can be contained in a specific area using spill kits. Safety showers and eye wash showers are used

Table 2. List of PPEs being used.

PPE	Applications
Safety glasses	Polycarbonate lens, side shields. Eye protection.
Direct vented	Working with particulates. Tends to fog less, but should not be used with liquid or fine dust hazards.
Indirect vented	Protects from splash entry by a hooded or covered vent.
Non vented	Protection from particulates, chemical splash, mist, liquid and vapors.
Disposable medical eye sheet	Protects from splash, spray, spatter or droplets of blood or other potentially infectious materials. Health care, biological Hazards.
Laser eyewear	Shaded glasses. Working with class 3 or class 4 lasers, consult laser use authorization for specific applications.
Surgical/procedure mask	Protects nose and mouth from direct contact with biological and chemical fluids and biological agents. Anatomical, surgical, medical and clinical settings.
Face shield	Impact and chemical resistant. Used in chemical splash, projectiles or cryogenic handling.
Disposable face shield	Protects from splash, spray, spatter or droplets of blood or other potentially infectious materials. Health care, biological hazards.
Optical face shield	To guard against ultraviolet or infrared radiations.
Welders googles	To avoid sparks during welding.
Welder's helmet	Protect eyes and face during welding from sparks, or ultraviolet and infrared radiations.
Arc rated face shield	Electrical safety applications.
Disposable nitrile gloves	Chemical hazards e.g. nitric acid and biological hazards.
Disposable vinyl gloves	Economical and for biological hazards.
Disposable latex gloves	Chemical resistant and biological hazards, working animals.
Leather gloves	Heat-resistant gloves, save from shrapnel and other metals.
Wire mesh gloves	Cut resistant, working with sharp instruments or animals.
Butyl gloves	Handling large chemicals or large spills.
Viton gloves	Chemical resistant, handling large spills.
Silver shield gloves	Handling large chemicals or large spills, methylene chloride
Terrycloth autoclave gloves	Heat resistant, hot equipment.
Flame resistant	Heat resistant due to fabrication materials, and pyrophoric handle.
Cryogen gloves	Cryogenic handling.
Electrical safety gloves	Insulated voltage rated rubber, electrical safety.
Disposable sleeves	Clothing and Skin protection, for handling particulates.
Disposable gowns	Clothing and Skin protection, biohazard, and animals.
scrubs	Layered protection, medical, clinical and surgical use.
Tyvek gown/coveralls	Clothing and skin protection, biological, chemical, animal, and airborne particulates protection.
Safety vest	Construction sites, traffic hazard areas, emergency response
Cooling vest	Hot environments.
Lab coats	Protects clothing, and skin, from dirt, ink, and nonhazardous chemicals.
Barrier	Does not permit blood, infectious materials, human blood, fluids, or tissues.
Flame resistant	Resist flame, for water, air reactive chemicals, flammable solvents, explosives.
Flame resistant coveralls	Resist flame, for water, air reactive chemicals, flammable solvents, explosives, welding or electrical systems.

Table 2 continued

PPE	Applications
Reflective clothing	Flame and heat resistant, hot environment, welding.
Leather apron, sleeves	Welding or shop work, sparks, projectiles.
Flame resistant apron	Flammable solvents, welding/electrical system.
Rubber coated wash apron	Chemical splash protection, and abrasion resistance.
Neoprene apron/sleeves	Chemical resistant, tear resistant, splash protection.
Cloth mask	Speaking, coughing, sneezing and particles vs respiratory.
Surgical and procedure mask	Droplets, splash, aerosols protection, cheap Corona control.
Dust mask	Dust, fumes, mist, microorganism, animal allergens.
N95 respirator	Infections and Corona control, dust, fumes, microorganisms.
Surgical N95 respirator	Respiratory protection is used during surgery.
N99, N100 respirators	Highest rated filtration efficiency, particulate prevention.
R95, R95 AG, OV	Protection, liquids especially oil-based particles.
R99, R10 respirators	Protection from acid gases, and painting dusts, 95% efficacy.
P95, P95 AG, OV P100 P99	Oil and non-oil based aerosols particles/ointments, petrochemical, pharmaceuticals, airborne particles.
Cartridge, half face air purifying, full face air purify	Particulates, dust, mist, fumes, combination.
Powered air purifying	Filtered air supply, BSL-3 environment, higher particles.
SCBA	Bulky, limited operation, high protection, expensive, oxygen deficient atmosphere, IDLH, airborne particles.
Radiation shield	Beta, gamma rays protection, radiations protection.
Chemical safety shield	Protection from chemical splash.
Blast protective shield	Overpressure and explosive protection.
Bouffant cap	Hygienic work environments, biohazards.
Flame resistant balaclava	Special electrical safety equipment.
Bump cap	Light weight plastic, low head clearance areas.
Hard hat	Metallic reinforced and light weight, overhead hazards.
Shoe cover	Hygienic work, non-slip shoes, floor contaminants.
Foot, shin guards, knee pads	Use metatarsal guards, and heavy materials protection.
Slip resistant shoes	Food service, animal facility, custodial application, medical/clinical applications.
Safety shoes	Metatarsal, steel toe, industry, heavy construction, crops.
Ear plugs	Noise, db, sounds, industry jobs sound, loud equipment.
Canal caps	Alarms, loud equipment, easy use.
Ear muffs	Reusable, Alarms, loud equipment, easy use.
Full body harness	Height, greater than 6 feet, confined space entry.
Locking carabiner	Fall protection system.
Lanyard switch	To trip conveyors if humans are trapped.
Shop absorbing lanyard	Harness to anchor connection, 18.5 feet fall clearance.
Self retracting lifeline	Greater worker mobility application, fall arrest.

for washing larger and smaller parts of the body respectively. Safety and eye wash showers must be operational throughout the year. First, second third-degree burns are directly linked with the severity of the burn. The first degree is upper skin layer damage, the second degree is affecting the meat of the body, however, the third-degree burn is that which penetrates deep and affects organs of the body. 24 terms are defining specific hazards of chemicals [57]. A chemical interaction matrix is also vital to be developed in industry, university and research laboratories [17]. The chemical interaction matrix indicates how chemical interaction can lead to worse consequences.

Corrosives destroy skin and other materials especially metallic. Corrosives may be gases, liquids, solids and solutions, e.g. HCl, HNO_3, H_2SO_4, NaOH, KOH, NH_4OH, NO_2, NH_3, H_2O_2, $KmNO_4$, HNO_3 [57]. Concentrated Nitric acid, 70% is harmful. The same is true for bases and other oxidizing solutions. Eyes epithelium can destroy in the pH 3–10 range. Corrosive may be generated during the reaction of two reactants; hence, extreme precautions are necessary.

3.4 Oceanic weathering

Gary Shaffer has indicated an increase in concentration of oceanic carbon dioxide, surface layers appear as 876 ppm compared to 126 ppm of the ancient or pre-industrial revolution period. Devastating effects of increased CO_2 concentration of 419 ppm compared to 280 ppm of 1750 indicate danger of CO_2 [58,59]. Rocks under oceans also get affected with acidic water and aquatic life will be in danger especially hidden under those rocks. Under 3000 m depth in ocean there are significant changes in CO_2 concentrations of 119 ppm to 700 ppm [60]. Increased CO_2 concentrations have put aquatic life in danger. Oceanic water layers may be used for carbonation specifically called oceanic weathering. This can be accomplished by spraying carbonate or bicarbonate on oceans as these will deter the effect of ocean acidity. Fine powders have significant surface area, and thus they will be better reactants or will dissolve earlier or easily. Steel slags, biomass waste, incinerator waste, municipal waste, human waste, cement waste ash and other alkaline wastes can be used for the said purpose.

3.5 Enhanced weathering

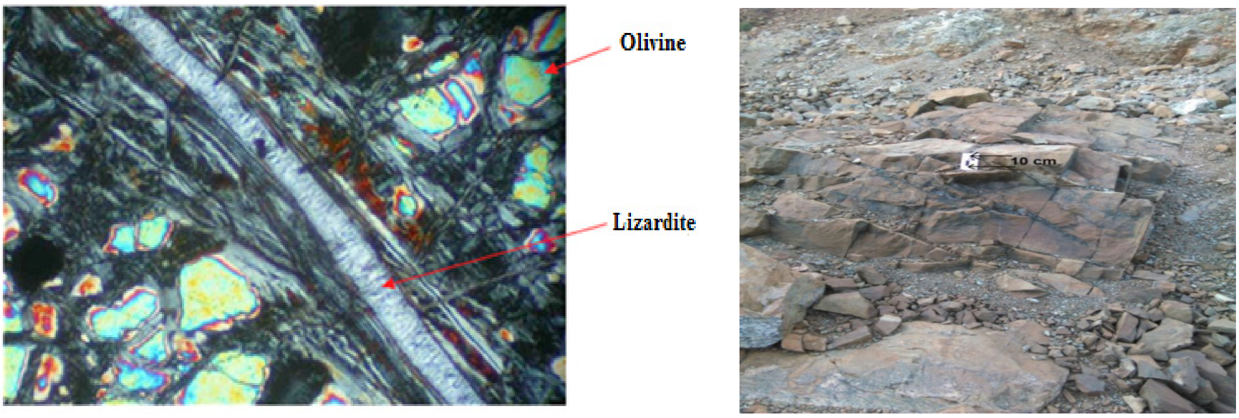
It includes mineral weathering, terrestrial weathering, and silicate weathering. This method uses different rocks and minerals for carbonation, aqueous mineral carbonation, single-stage, two-stage, gas-solid carbonation and acid dissolution or carbonic acid dissolution. Basalt weathering may reduce the 2% emissions fraction with respect to the total annual emissions of Austria by applying enhanced weathering [16]. Enhanced weathering is a negative emission technology [61]. However, net zero emissions are doubtful to achieve.

3.6 Mineral weathering

Figure 4a is the microscopy image showing a serpentine vein partially cutting serpentinized olivine. **Figure 4b** represents the Doonba deposit (GSB (Great Serpentine Belt), Tamworth, Australia) from where dunite was collected.

Hand specimen: The sample is composed of a massive, dark grey-green, partly serpentinized dunite, i.e. olivine-rich rock. It contains finely granular greenish, semi-translucent olivine, partly replaced by fine grained grey serpentine minerals. There are also a few shiny, sub-metallic black grains of chromite. The rock is moderately magnetic, with a susceptibility of 200×10^{-5} SI units.

Petrographic description: In the section, it is evident that there is considerable relict olivine, with the relicts indicating that the original dunite was coarse grained (up to 5 mm), with abundant interlocking olivine grains, forming a polygonal aggregate. Triple-point junctions between grains are typical. There are also sparsely scattered chromite grains up to 1.2 mm across, generally enclosed by olivine, and a few interstitial clinopyroxene grains up to 2 mm across. Olivine was strongly fractured and the fracture system was the control for ensuing



(a) (b)

Figure 4. Microscopic analysis of dunite (a) Serpentine vein cutting partly serpentinized olivine (pale green). Replacement serpentine (lizardite) is mostly dark grey and non-fibrous (b) North wall of the dunite quarry at Doonba deposit, GSB, NSW, Australia, north wall height is approximately 1 meter.

serpentinization (**Figure 5**). Olivine was partly to completely replaced by fine grained pale green to pale orange-brown serpentine (probably mostly lizardite) forming a typical "mesh" texture (**Figure 6**) and containing a trace of fine-grained magnetite along thin septa reflecting the position of the original olivine grain boundaries. Clinopyroxene was largely preserved, and chromite was slightly replaced by ferrichromite/magnetite. None of the replacement serpentine has a definite fibrous texture. The rock is cut by a couple of thin, sub-planar veins up to 0.1 mm thick (**Figure 4a**), containing granular to possibly weakly cross-fibre texture serpentine, with trace carbonate in places. Serpentine could include lizardite and chrysotile. The total amount of possible fibrous material in the sample is < 1 %. It is possible that minor brucite formed during the replacement of olivine, but this mineral is optically difficult to discern from the serpentine minerals. If present, it could be detected by XRD analysis. After cleaning definite size bins (20–45 μm, 45–75 μm, 75–150 μm), our estimated amount of fines was below 0.25% for all the size bins.

Mineral Mode (by volume): serpentine minerals (lizardite 60%, olivine 37%, chromite 2%, clinopyroxene 1% and traces of magnetite/ferrichromite and carbonate.

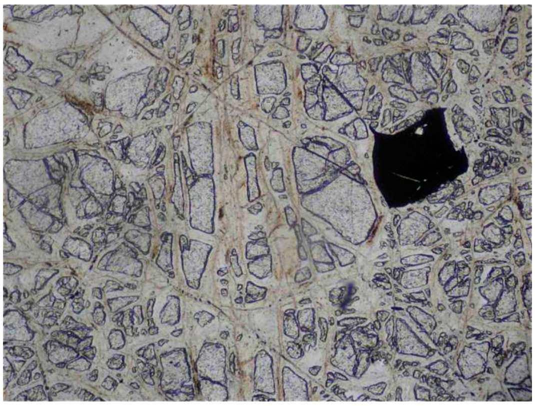


Figure 5. Typical mesh texture developed from the serpentinization of fractured olivine (clear, higher relief grains). Olivine is enclosed by serpentine (lizardite). The dark brown-black grain is chromite. Plane polarised transmitted light, field of view 2 mm across.

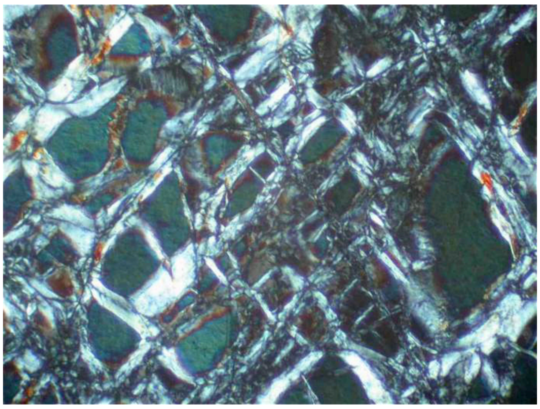
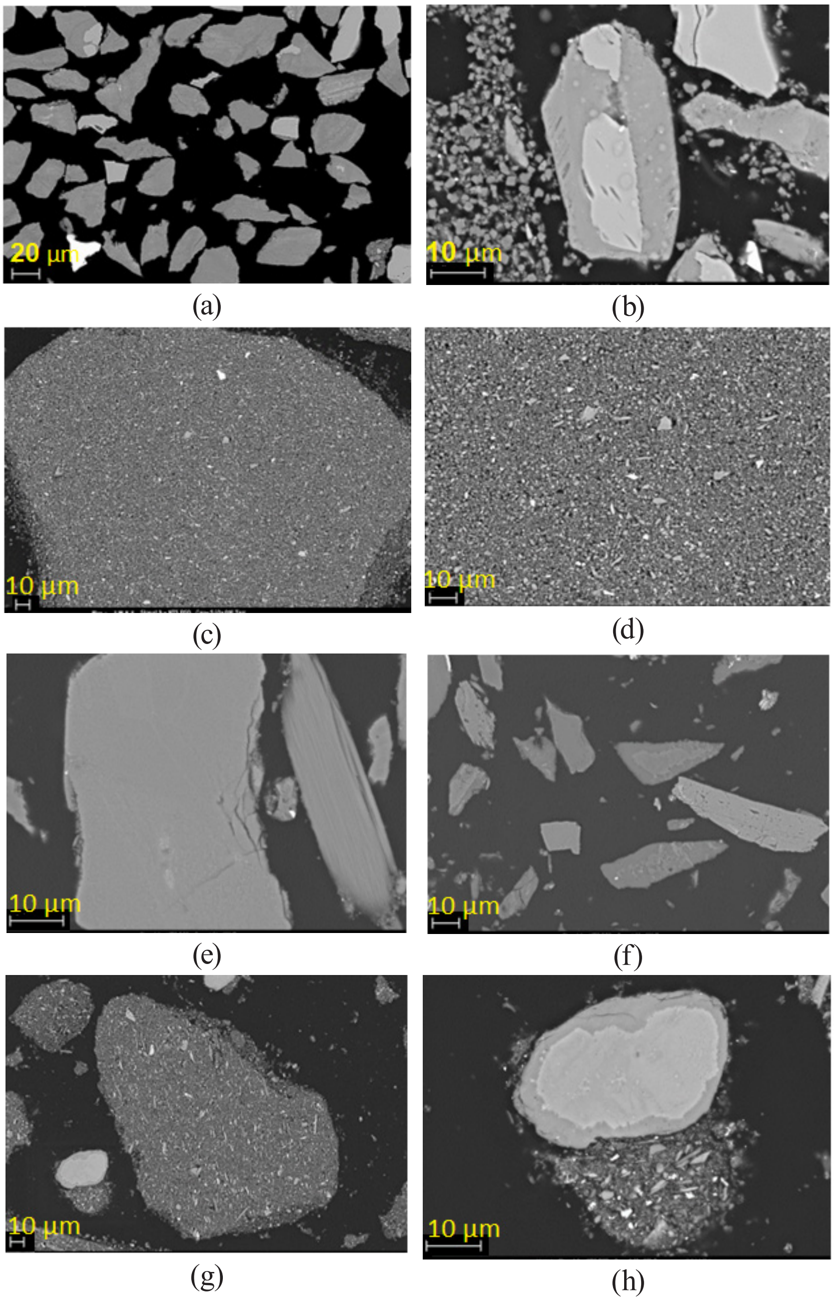


Figure 6. Mesh texture developed by serpentinization of olivine (dark grey-green). Replacement serpentine (lizardite) ranges from dark grey to white. It is largely non-fibrous. Transmitted light, crossed polars, field of view 1 mm across.

Minerals weathering was observed when keeping the minerals without carbonation in a storage room and their yield was reduced due to the formation of thick silica-rich layers on mineral particles. Silica-rich layer formation and disruption are observed during single-stage and two-stage carbonation [18,34,35,62,63]. Particles having silica-rich layers are shown in **Figure 7**.

Dunite feed is shown in **Figure 7a**. Silica-rich layers develop during carbonation reaction as shown in **Figure 7b**. Concurrent ground product is shown in **Figures 7c and 7d**. The Lizardite feed is shown in **Figure 7e**. The reference experiment product in which no grinding media was used is shown in **Figure 7f**. Concurrent ground carbonated product is shown in **Figure 7g**. Concurrent ground carbonated product particles having silica-rich layers are shown in **Figure 7h**.



(a) (b)

(c) (d)

(e) (f)

(g) (h)

Figure 7. Feed and carbonated products, Dunite feed (a), Silica-rich layers (b), concurrent ground (c), concurrent ground (d), lizardite feed (e), heat-activated lizardite reference experiment (f), concurrent ground product (g), one particle still has remaining silica rich layer, clear zoom view of the single remaining particle (h).

Dunite serpentinization is similar to olivine serpentinization which transforms olivine into lizardite. Still these transformed rocks and minerals can be employed in mineral carbonation [18,26,28–30,32–35,37]. Mineral carbonation converts CO_2 into mineral carbonates due to a reaction with magnesium silicates [35]. This is irreversible, as heating the carbonate at normal temperature and pressure will not bring CO_2 back, until unless magnesite is heated above 800 °C and even higher. $CaCO_3$ is used in the cement industry, it can partially be replaced with magnesite or $MgCO_3$. For this purpose 100% pure magnesite is required which is possible in two-stage carbonation [34]. Another option is converting silicates via mineral carbonation into silica or enriched silica residue and using it as a pozzolanic material in the cement industry [28]. Carbonated products and feedstock can be used in the cement industry [30]. Dunite used in mineral carbonation is a mixture of various minerals. Different fractions of dunite have been analysed by TGA-MS analysis and semi QXRD. XRD samples were scanned for 4 hours from 11–31° followed by their analysis by QXRD. 20–45 and 45–75 µm fractions are rich in olivine and lean in brucite and magnetite (**Table 3**). TGA-MS results match with QXRD results.

The ratio of lizardite to olivine without normalisation (QXRD) is provided in **Table 4** which shows the accuracy of QXRD analysis. Lizardite to olivine ratio is constant thus verifying that QXRD results are authentic. QXRD results also match with TGA-MS results.

Table 3. Dunite fractions TGA-MS and semi QXRD analysis.

Sr. No	Lizardite	Olivine	Brucite	Magnetite
–20 µm dunite TGA-MS	70	20 (difference)	9.5	0.5 (XRD)
–20 µm dunite TGA-MS repeat	64	27 (difference)	8.5	0.5 (XRD)
20–45 µm dunite TGA-MS	52	42 (difference)	5.9	0.5 (XRD)
20–45 µm dunite TGA-MS repeat	51	43(difference)	5.3	0.5 (XRD)
20–45 µm dunite QXRD	52	42	5.4	0.46
20–45 µm dunite QXRD repeat	52	42	5.7	0.48
20–45 µm dunite QXRD repeat	53	41	5.7	0.49
45–75 µm dunite TGA-MS	43	51(difference)	5.5	0.35 (XRD)
45–75 µm dunite TGA-MS repeat	45	49 (difference)	5.8	0.35 (XRD)
45–75 µm dunite QXRD	43	51	5.6	0.35
45–75 µm dunite QXRD repeat	44	50	5.8	0.33
45–75 µm dunite QXRD repeat	43	51	6.03	0.404
75–150 µm dunite TGA-MS	46	48 (difference)	5.2	0.5 (XRD)
75–150 µm dunite TGA-MS repeat	57	37 (difference)	6.1	0.5 (XRD)

Table 4. Calculation details of QXRD.

Sample 1. QXRD Calculation Details						
Csi	Cliz	Coli	Cbru	Cmag	Total	Lizardite/Olivine
20	75	59	8.3	0.29	163	75/59 = 1.2564
Exclude silicon	52	41	5.8	0.202	100	1.2564
Sample 2. QXRD Calculation Details						
Csi	Cliz	Coli	Cbru	Cmag	Total	Lizardite/Olivine
20	71	56	7.1	0.26	155	71/56 = 1.2567
Exclude silicon	52.6	42	5.2	0.19	100	1.2567
Sample 3. QXRD Calculation Details						
Csi	Cliz	Coli	Cbru	Cmag	Total	Lizardite/Olivine
20	60	45	6.8	0.26	132	60/45 = 1.32
Exclude silicon	53	40	6.1	0.23	100	1.32

3.7 Terrestrial weathering

Terrestrial weathering is costly as fine powders of silicate minerals are used. Comminution/grinding is vital for its successful implementation.

3.8 Silicate's weathering

Those countries having surplus electricity can implement this strategy. This may be called best energy policy and greenhouse gas mitigation. Canal water agglomerates are removed, and water is purified using aluminum silicates.

4. Conclusions

Climate change and extreme weathering are affecting all materials. Surface coatings can extend the life of various materials. The ideal coating system would combine the performance benefits of solvent-based coatings with the environmental, health, and safety benefits of water-based coatings. Corrosion can be prevented by reducing water/acid/base contact with solid materials. Oceanic water layers may be used for carbonation by spraying carbonate or bicarbonate on oceans.

Author Contributions

Muhammad Imran Rashid, data curation, writing the original draft. Sikander Rafiq, analysis, reviewing the original draft. Mahnoor Asif, data curation, analysis. Ayesha Mobeen, data curation, analysis.

Conflict of Interest

There is no conflict of interest.

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