***SCRREEN2***

*This project has received funding from the European*

*Union's Horizon 2020 research and innovation programme*

*under grant agreement No 958211.*

Start date: 2020-11-01 Duration: 36 Months

FACTSHEETS UPDATES **BASED ON THE EU FACTSHEETS 2020**

# PERLITE

AUTHOR(S):

## TABLE DES MATIÈRES




This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958211

# PERLITE

## OVERVIEW

Perlite is a generic term for naturally occurring siliceous rock. It is a volcanic glass with sufficient water content to cause it to expand, or froth up, when heated, forming a lightweight granular aggregate. Perlite is commonly used in its expanded form. Perlite's low density and porous texture (expanded form), low thermal conductivity, high sound absorption and chemical stability makes it a suitable material for a diverse range of applications including construction, horticulture, insulation, filtration and industrial uses.

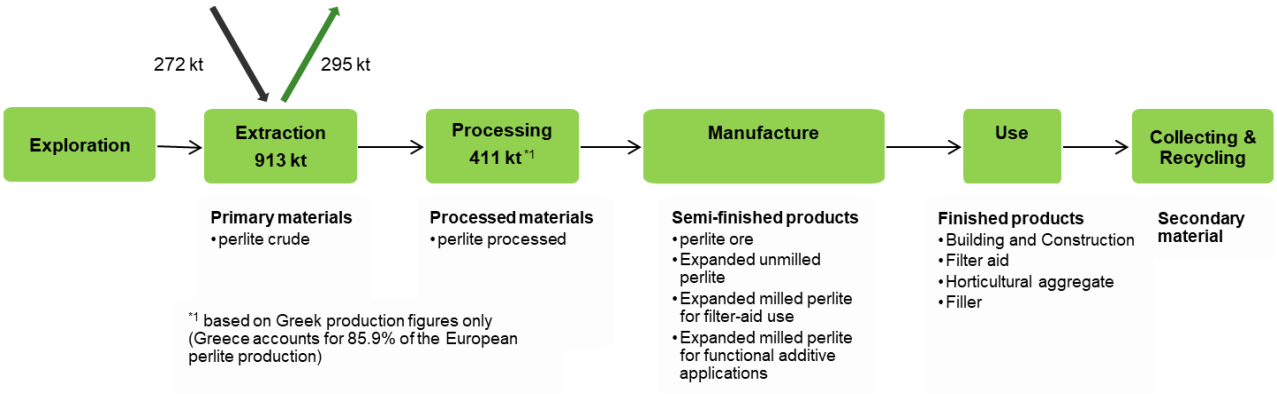


**Figure 1. Simplified value chain for perlite in the EU[1]**

**Table 1. Perlite supply and demand in metric tonnes, 2016-2020 average**

| Global production | Global Producers | EU consumption | EU Share | EU Suppliers | Import reliance |
|---|---|---|---|---|---|
| **4,718,374** | China 30%<br>Turkey 24%<br>Greece 17%<br>US 11%<br>Iran 10% | 974,249 | 20.6% | Turkey 58%<br>South Africa 22%<br>UK 11%<br>Zimbabwe 3% | 0% |

**Prices:** The average annual value of f.o.b. perlite in 2020 was EUR 56 per tonne (USGS, 2022a). Expanded perlite unit values ranged from EUR 617 per tonne for low-temperature insulation to EUR 180 per tonne for formed products. This broad range is a function of the end use and quality of the perlite needed for varying products.

**Primary supply:** The global production of perlite in 2020 slightly exceeded 4.7 Mt, while the EU distribution corresponds to about the 20% of the global production. China, Turkey, Greece, US and Iran are the major producing countries, but production of perlite takes place in several other countries at much smaller scale. The 5 years average EU production of perlite between 2016 and 2020 was 1,883 kt per year, which accounts for almost 26% of the global production. Producing countries include Greece, Hungary, Italy, Slovakia and Bulgaria (Eurostat, 2021). In Greece major perlite production comes from the island of Milos and in Turkey

[1] JRC elaboration on multiple sources (see next sections)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958211

perlite is produced from the Western part of the country. Imerys S.A. is the most important supplier of perlite and the company owns important deposits both in Greece and Turkey (BGS, 2019). Greece produces 91% of the European perlite.

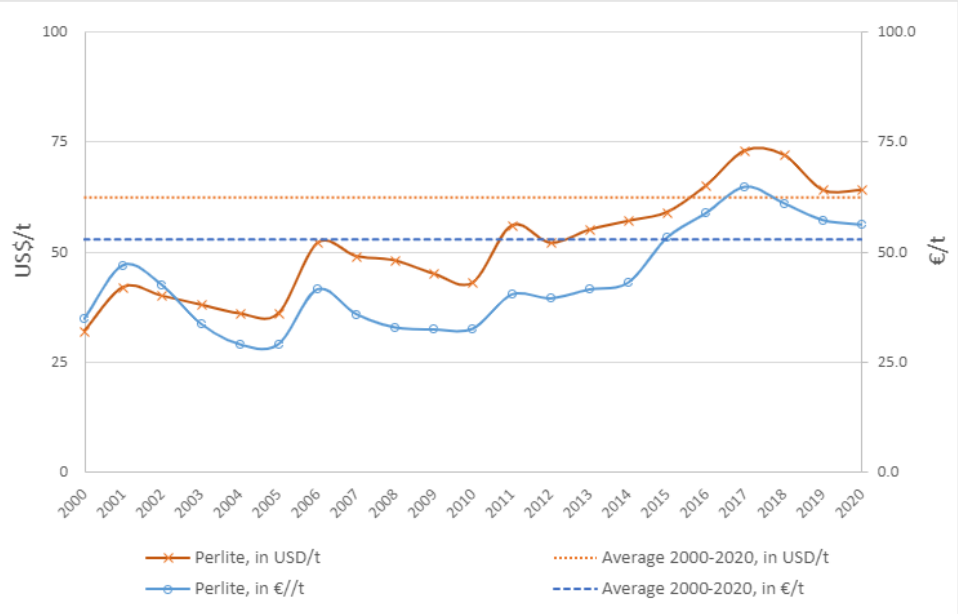


**Figure 2. Annual average price of perlite between 2000 and 2020 ( USGS, 2021)[2].**

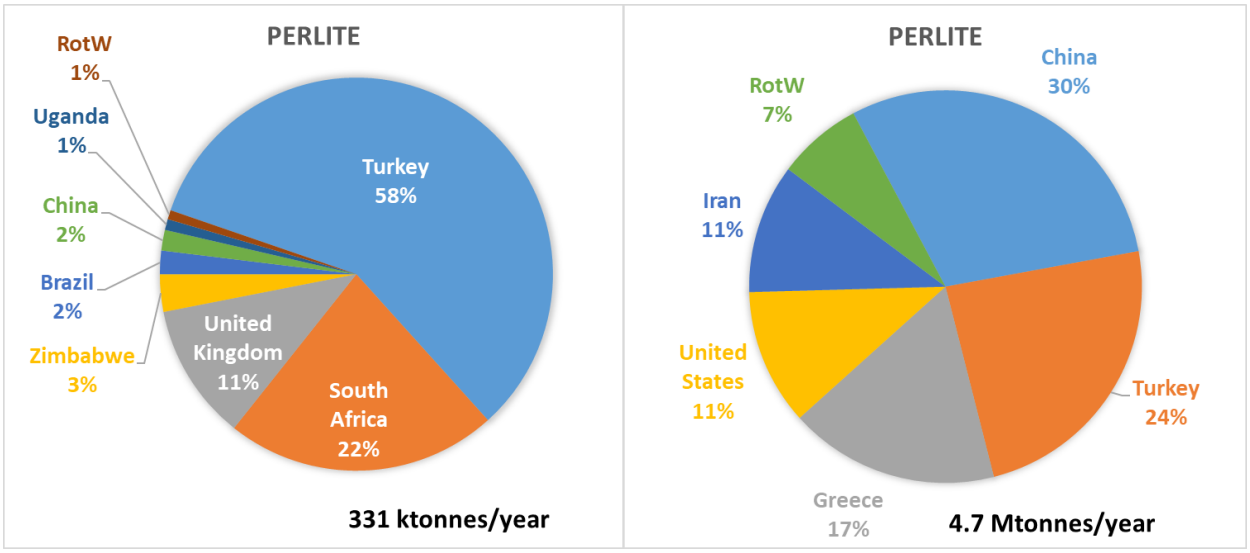


**Figure 3. EU sourcing of perlite and global mine production (update)**

**Secondary supply:** Perlite is not commonly recovered from waste and therefore there is no availability of perlite from secondary sources. However, construction and demolition waste, which represents the most important application for perlite, is widely recycled across the EU. The recycling of mineral-based waste in EU, based on Eurostat data, is estimated at 42%.

[2] Values in €/kg are converted from original data in US$/kg by using the annual average Euro foreign exchange reference rates from the European Central Bank (https://www.ecb.europa.eu/stats/policy_and_exchange_rates/euro_reference_exchange_rates/html/eurofxref-graph-usd.en.html)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958211

**Uses:** Perlite is used in building construction products, as filler in several applications, as horticultural aggregate and in filter aid applications.

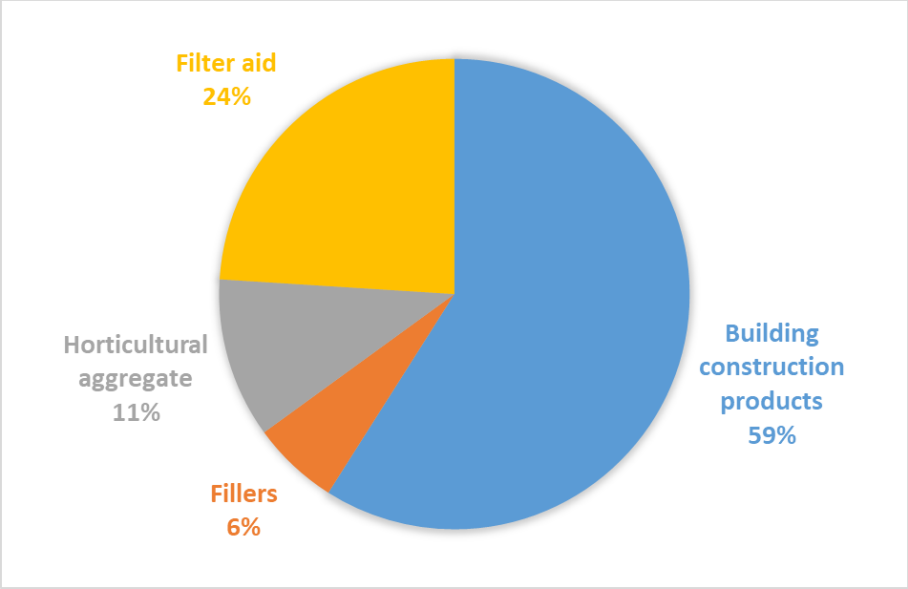


**Figure 4: EU uses of perlite**

**Substitution:** Substitutes for perlite have been identified in building construction products, fillers, horticultural aggregate and filter media. Substitutes are assigned a 'sub-share within' a specified application and considerations of the cost and performance of the substitute, as well as the level of production, whether the substitute has a 'critical' status and produced as a co-product/by-product.

**Table 2. Uses and possible substitutes**

| Use | Share* | Substitutes | Sub share | Cost | Performance |
|---|---|---|---|---|---|
| **Building construction products** | 59% | Expanded clay | 20% | Similar or lower costs | Reduced |
| | | Other | 5% | Slightly higher costs (up to 2 times) | Similar |
| | | Vermiculite | 20% | Slightly higher costs (up to 2 times) | Similar |
| | | Pumice | 5% | Similar or lower costs | Reduced |
| **Fillers** | 6% | Diatomite | 8% | Similar or lower costs | Similar |
| | | Expanded clay | 8% | Similar or lower costs | Similar |
| | | Expanded shale | 8% | Similar or lower costs | Similar |
| | | Slag | 8% | Similar or lower costs | Similar |
| | | Vermiculite | 8% | Similar or lower costs | Similar |
| | | Pumice | 8% | Similar or lower costs | Similar |
| **Horticultural aggregate** | 11% | Vermiculite | 15% | Slightly higher costs (up to 2 times) | Reduced |
| | | Pumice | 30% | Similar or lower costs | Reduced |
| | | Expanded clay pellets | 2% | Similar or lower costs | Reduced |
| | | Other horticultural aggregates | 3% | Slightly higher costs (up to 2 times) | Reduced |
| **Filter aid** | 24% | Diatomite | 40% | Similar or lower costs | Similar |
| | | Expanded clay | 3% | Similar or lower costs | Similar |

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958211

| | | | | | |
|---|---|---|---|---|---|
| | | Rice hull ash | 10% | Slightly higher costs (up to 2 times) | Similar |
| | | Cellulose | 10% | Slightly higher costs (up to 2 times) | Similar |
| | | Pumice | 3% | Similar or lower costs | Similar |

* EU end uses of perlite 2018 (IMA, 2019), Perlite Institute, 2022).

**Other issues:** The International Association for Sustainable Building and Living developed Guideline 0408. The guideline defines criteria for being awarded with the natureplus eco-label for perlite boards for internal applications. The Eco-label is classified as a Type I environmental label as per ISO 14024, taking into consideration the EU Ecolabel Regulation and the EMAS regulation on environmental auditing, and is valid across the whole of Europe according to uniform criteria.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958211

## GLOBAL MARKET

Table: Perlite (extraction) supply and demand in metric tonnes, 2016-2020 average

| Global production | Global Producers | EU consumption | EU Share | EU Suppliers | Import reliance |
|---|---|---|---|---|---|
| **4,718,374** | China 30%<br>Turkey 24%<br>Greece 17%<br>US 11%<br>Iran 10% | 974,249 | 20.6% | Turkey 58%<br>South Africa 22%<br>UK 11%<br>Zimbabwe 3% | 0% |

In 2021, China, Turkey, Greece, and the US were the main global world producers with 36%, 29%, 17%, and 12%, respectively (USGS, 2022a). Greece and Turkey remained the leading exporters of perlite as China production was consumed domestically (USGS, 2022a). Exports from Greece were mainly to the US (USGS, 2019), while perlite exports from Turkey were consumed by the EU and Russia.

The global future of perlite is closely connected to the future of the construction industry. Building and infrastructure construction-related projects are expected to increase in the future and as such the consumption of perlite is likely to increase. Expanded perlite plants in the United States rely on imports of perlite from Europe and this trend is expected to continue. Project planning progressed at a perlite deposit in Nevada that could be developed as a potential supplier of crude perlite ore for household and industrial applications (USGS, 2022a).

## EU TRADE

For this assessment, perlite is evaluated at extraction stage.

**Table 3. Relevant Eurostat CN trade codes for perlite.**

| Mining | |
|---|---|
| **CN trade code** | **title** |
| **25301010 (<2010)**<br>**25301090 (<2010)**<br><br>**25301000 (>2009)** | Vermiculite, perlite and chlorites, unexpanded |

Figure 5 shows the import and export trend of perlite from 2000-2020. It shows that imports and exports are in the same order of magnitude, around 350,000 tonnes per year in the observed period. Among the EU member states, Greece remained as leading exporter of perlite (USGS, 2022). The major suppliers of this perlite to the EU in the observed period are Turkey (5%), South Africa (22%) and United Kingdom (11%) (Figure 6).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958211

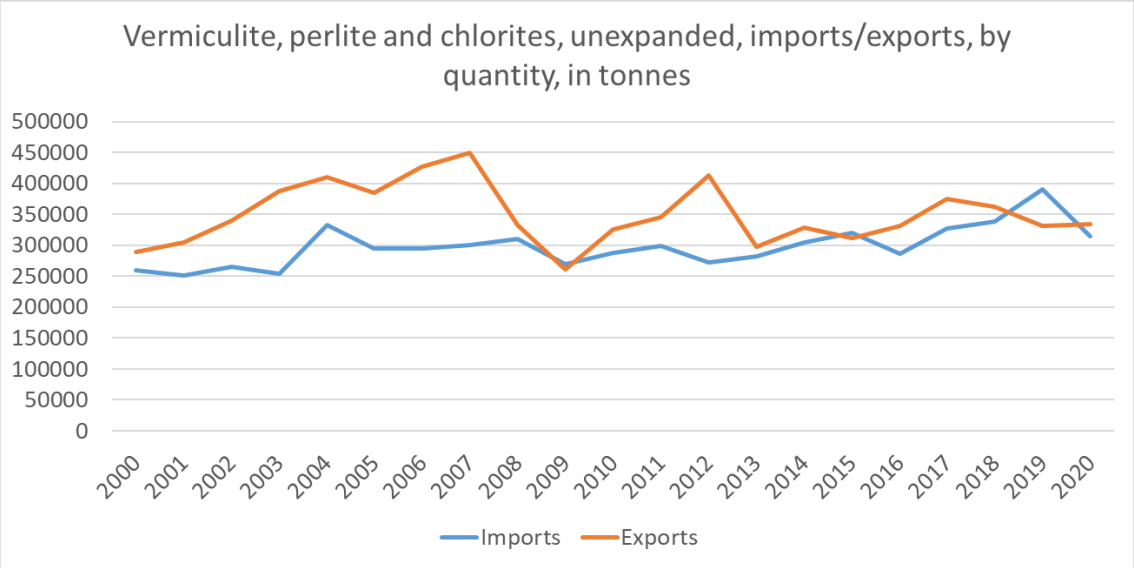


**Figure 5. EU trade flows of vermiculite, perlite and chlorites (CN 25301010 and 25301090 before 2010 and 25301000 from 2010) from 2000 to 2021 (Eurostat, 2022)**

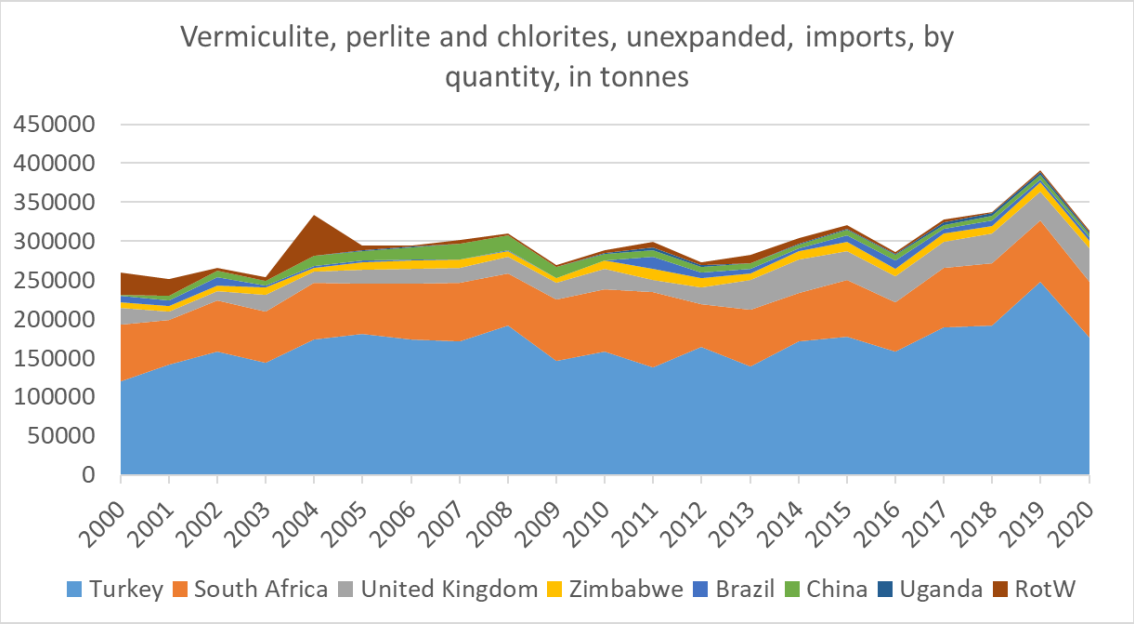


**Figure 6. EU imports of vermiculite, perlite and chlorites (CN 25301010 and 25301090 before 2010 and 25301000 from 2010) by country from 2000 to 2021 (Eurostat, 2022)**

## PRICE AND PRICE VOLATILITY

The average annual value of f.o.b. perlite in 2020 was EUR 56 per tonne (USGS, 2022a). Expanded perlite unit values ranged from EUR 617 per tonne for low-temperature insulation to EUR 180 per tonne for formed products. This broad range is a function of the end use and quality of the perlite needed for varying products (USGS, 2022b).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958211

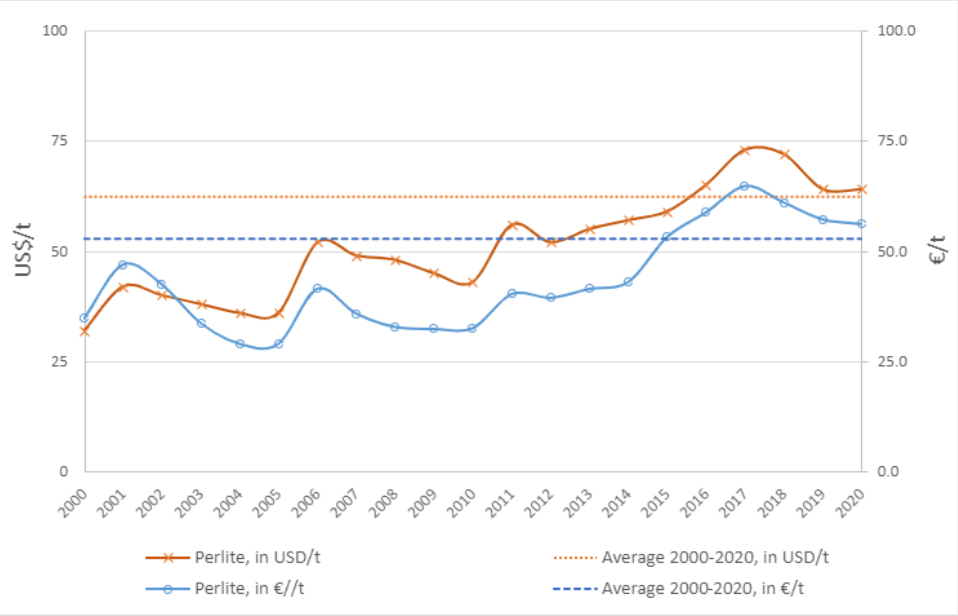


**Figure 3. Annual average price of perlite between 2000 and 2020, in US$/t and €/t f.o.b. mine[3]. Dash lines indicate average price for 2000-2020 (USGS, 2022b)**

## DEMAND

### GLOBAL AND EU DEMAND AND CONSUMPTION

Perlite EU consumption is assessed at extraction stage. Perlite extraction stage EU consumption is presented by HS code CN 25301010 and CN 25301090 before 2010 and CN 25301000 from 2010- Vermiculite, perlite and chlorites, unexpanded. Import and export data is extracted from Eurostat Comext (2022). Production data is extracted from WMD (2022).

[3] Values in €/kg are converted from original data in US$/kg by using the annual average Euro foreign exchange reference rates from the European Central Bank (https://www.ecb.europa.eu/stats/policy_and_exchange_rates/euro_reference_exchange_rates/html/eurofxref-graph-usd.en.html)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958211

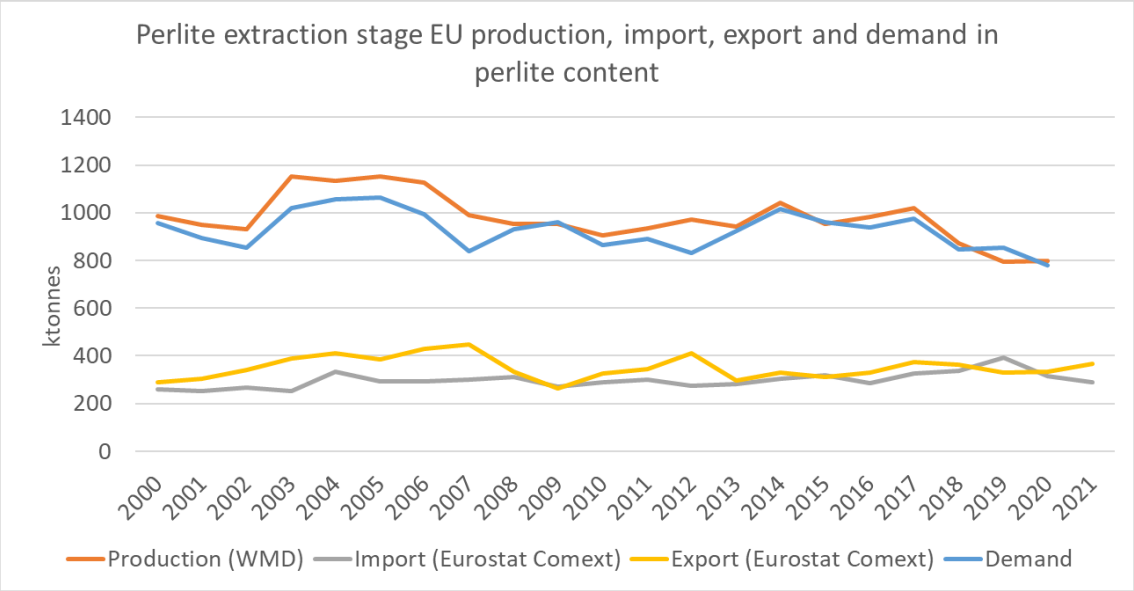


**Figure 7. Perlite (CN 25301010 and CN 25301090 before 2010 and CN 25301000 from 2010) extraction stage apparent EU consumption. Production data is available from WMD (2022). Consumption is calculated in perlite content (EU production+import-export).**

Average import reliance of perlite at extraction stage is 0 % for 2016-2020.

## EU USES AND END-USES

Perlite is used in building construction products, as filler in several applications, as horticultural aggregate and in filter aid applications.

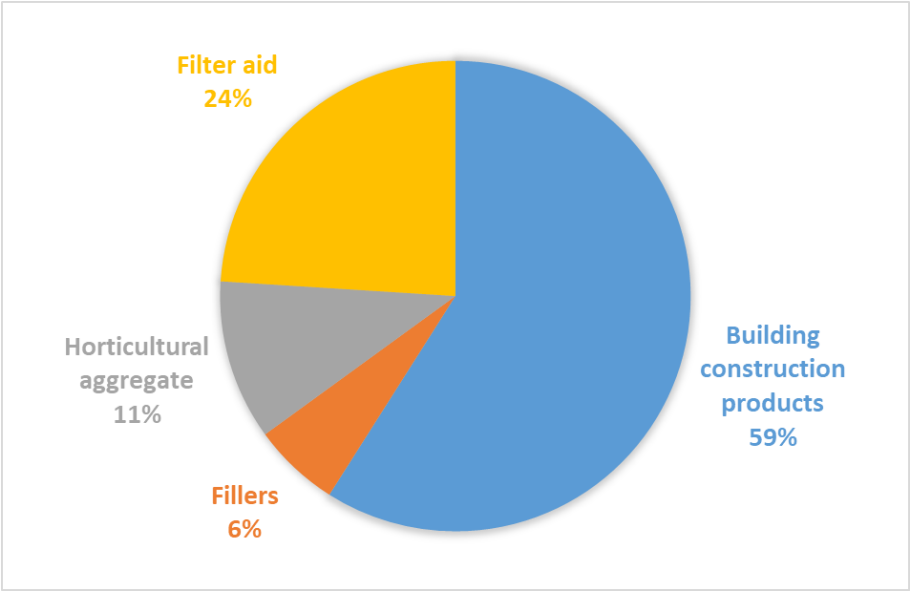


**Figure 8. EU end uses of perlite 2018 (IMA, 2019), Perlite Institute, 2022).**

Relevant industry sectors are described using the NACE sector codes (Eurostat, 2019c).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958211

**Table 4. Perlite applications (Perlite Institute, 2022), 2-digit and associated 4-digit NACE sectors, and value added per sector (Eurostat 2022)**

| Applications | 2-digit NACE sector | Value-added of sector (millions €) -2019 | Examples of 4-digit NACE sector |
|---|---|---|---|
| Building construction products | C23 - Manufacture of other non-metallic; mineral products | 69,888.20 | C2361 Manufacture of concrete products for construction purposes; C2364 Manufacture of mortars; 23.65 Manufacture of fibre cement 23.70 Cutting, shaping and finishing of stone C2332 Manufacture of bricks, tiles and construction products, in baked clay. |
| Fillers | C23 - Manufacture of other non-metallic mineral products | 69,888.20 | C2920 - Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers |
| Horticultural aggregate | C23 - Manufacture of other non-metallic mineral products | 69,888.20 | C2811 - Manufacture of engines and turbines, except aircraft, vehicle and cycle engines |
| Filter aid | C11 - Manufacture of beverages | 32,505.0 | C2571 - Manufacture of cutlery |

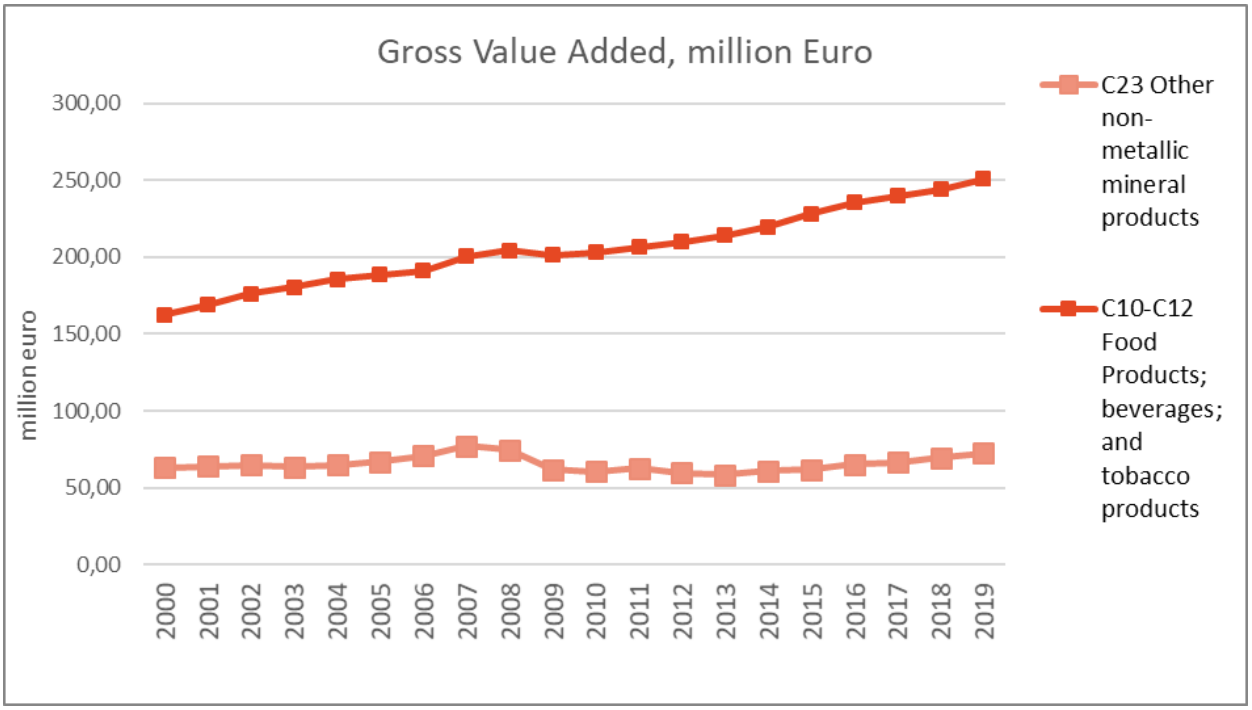


**Figure 9. Value added per 2-digit NACE sector over time (Eurostat, 2022)**

## BUILDING AND CONSTRUCTION

Perlite plays an important role in a wide variety of construction-related uses including as an aggregate in lightweight insulating concrete and plaster; as a loose fill insulation material for concrete masonry blocks, cavity walls, in residential homes; and in a variety of specialty applications including fireproofing sprays, chimney fills, interstitial floors, acoustical sprays, etc. (Perlite Institute, 2022).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958211

### FILLERS

Perlite fillers made up of clusters of glass bubbles are used in a wide variety of applications – some of the most common being in the production of acoustic ceiling tiles, lightweight cement, and insulating plasters. Perlite finds use as a filler in explosives, caulking media, paints, plastics and packing for shipping products (Perlite Institute, 2022).

### HORTICULTURAL AGGREGATES

In agriculture and horticulture, perlite is used mainly as substrate, and is popular in hydroculture due to its capacity to encourage root growth and promote long life and production of plants.

### FILTER AID

Perlite is used in liquid filtration in a range of products including beer, wine, edible oils, citric acid, sugars, oils, pharmaceuticals, and water filtrations.

In air filtration perlite is used as a pre-coat for baghouses.

Perlite, like diatomite, is a functional filtration component of depth filter sheets and pads.

## SUBSTITUTION

**Table 5. Uses and possible substitutes**

| Use | Share* | Substitutes | Sub share | Cost | Performance |
|---|---|---|---|---|---|
| **Building construction products** | 59% | Expanded clay | 20% | Similar or lower costs | Reduced |
| | | Other | 5% | Slightly higher costs (up to 2 times) | Similar |
| | | Vermiculite | 20% | Slightly higher costs (up to 2 times) | Similar |
| | | Pumice | 5% | Similar or lower costs | Reduced |
| **Fillers** | 6% | Diatomite | 8% | Similar or lower costs | Similar |
| | | Expanded clay | 8% | Similar or lower costs | Similar |
| | | Expanded shale | 8% | Similar or lower costs | Similar |
| | | Slag | 8% | Similar or lower costs | Similar |
| | | Vermiculite | 8% | Similar or lower costs | Similar |
| | | Pumice | 8% | Similar or lower costs | Similar |
| **Horticultural aggregate** | 11% | Vermiculite | 15% | Slightly higher costs (up to 2 times) | Reduced |
| | | Pumice | 30% | Similar or lower costs | Reduced |
| | | Expanded clay pellets | 2% | Similar or lower costs | Reduced |
| | | Other horticultural aggregates | 3% | Slightly higher costs (up to 2 times) | Reduced |
| **Filter aid** | 24% | Diatomite | 40% | Similar or lower costs | Similar |
| | | Expanded clay | 3% | Similar or lower costs | Similar |
| | | Rice hull ash | 10% | Slightly higher costs (up to 2 times) | Similar |
| | | Cellulose | 10% | Slightly higher costs (up to 2 times) | Similar |
| | | Pumice | 3% | Similar or lower costs | Similar |

* EU end uses of perlite 2018 (IMA, 2019), Perlite Institute, 2022).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958211

Substitutes for perlite have been identified in building construction products, fillers, horticultural aggregate and filter media. Substitutes are assigned a 'sub-share within' a specified application and considerations of the cost and performance of the substitute, as well as the level of production, whether the substitute has a 'critical' status and produced as a co-product/by-product.

## BUILDING CONSTRUCTION PRODUCTS

Substitutes for perlite used in building construction products include expanded clay, vermiculite, diatomite and pumice.

Several other materials could be used as lightweight aggregate depending on the product and material availability, including, diatomite, expanded shale, pulverized fly ash, slag, glass.

Expanded clay may substitute perlite in masonry and mortal products primarily, but its use reduces the performance of the product.

Vermiculite may substitute perlite in flame retardant products as it provides similar performance, but is more expensive than perlite.

Pumice may also substitute perlite in some cases.

## FILLERS

Perlite may be substituted by pumice, vermiculite, slag, diatomite, expanded clay and shale and numerous other industrial minerals in filler applications. The degree of substitution by any of these materials is governed by the end product specification, material availability and material cost.

## HORTICULTURAL AGGREGATES

In horticultural applications, perlite may be substituted primarily by pumice and vermiculite, but also by zeolite, expanded clay and numerous other products, such as rockwool, stonewool, coco-coir, sawdust, sphagnum peat moss, rice hulls and many more. The use of zeolite may enhance productivity in agricultural applications.

## FILTER AIDS

Filter aid is used in solid-liquid separation. In filter aid applications, the primary substitute of perlite is diatomite, which comprises a popular filter media.

Cellulose and rice husk ash can be used, including expanded clay and pumice.

Cellulose is used for coarse filtration applications and where silica cannot be tolerated.

Zeolite may be a potential substitute in filters (SCRREEN Workshop, 2019).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958211

## EU SUPPLY CHAIN

The 5 years average EU production of perlite between 2016 and 2020 was 1,883 kt per year, which accounts for almost 26% of the global production. Producing countries include Greece, Hungary, Italy, Slovakia and Bulgaria (Eurostat, 2021). The larger amounts of imported perlite in EU originate from Turkey, South Africa and United Kingdom. On the other hand, EU is a net exporter of perlite and the primary destinations of the European perlite is the United States, Israel and Canada. The larger amounts of imported perlite originate from Turkey, South Africa and United Kingdom. The majority of imported perlite is consumed within Europe. There are no export restrictions, quotas or prohibitions identified that may impact on the availability of perlite.

## SUPPLY FROM PRIMARY MATERIALS

### GEOLOGY, RESOURCES AND RESERVES OF PERLITE

#### GEOLOGICAL OCCURRENCE

Perlite is hydrated volcanic glass formed by the chemical weathering of obsidian at or near the earth's surface. Commercial deposits are mainly related with Tertiary and Quaternary volcanism. Perlite occurs as lava flows, dykes, sills and circular or elongated domes, with the domes representing the largest and commonest deposits. However, the best resources is the glassy top of a permeable high-silica lava flow. Large domes tend to yield less perlite due to complex multi-event cooling histories, which form interleaved mixtures of glass and rhyolite (Kogel et al, 2016; Evans, 1993).

Overall, the formation of perlite deposits is complex requiring several essential consecutive events to take place and it is determined by the eruptive history of the parent volcano. Perlite is often classified by industry according to its texture as pumiceous (least dense), granular and onion skin (most dense). Pumiceous perlite is characterized by a frothy open vesicles texture. Granular perlite has a sugary and blocky fracture and onionskin perlite has a well-defined curved perlitic fracture and a pearly to resinous luster. Most commercial perlite is granular, or pumiceous (Kogel et al, 2016).

#### GLOBAL RESOURCES AND RESERVES

**Table 6. Global reserves of perlite in 2021 (USGS, since 2000)**

| Country | Perlite Reserves (kt) |
|---|---|
| United States | 50,000 |
| Greece | 120,000 |
| Hungary | 49,000 |
| Iran | 73,000 |
| Turkey | 57,000 |

Selective reserve figures of perlite for 2021 are shown in Table 1. A global reserve figure cannot be estimated as data from several important producing countries are missing.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958211

Reserve data for Ukraine are also available at Minerals4EU (2019) but cannot be summed as they are partial and they do not use the same reporting code (Table 2).

**Table 7. Reserve data for Ukraine compiled in the European Minerals Yearbook at Minerals4EU (2019)**

| Country | Reporting code | Quantity | Unit | Grade | Code reserve type |
|---|---|---|---|---|---|
| Ukraine | Russian Classification | 2980.8 | Thousand $m^3$ | - | A |

## EU RESOURCES AND RESERVES

Resource data for some EU countries and Turkey are available at Minerals4EU (2019) but cannot be summed as they are partial and they do not use the same reporting code (Table 3).

**Table 8. Resource data for the EU compiled in the European Minerals Yearbook at Minerals4EU (2019)**

| Country | Reporting code | Quantity | Unit | Grade | Code resource type |
|---|---|---|---|---|---|
| UK | None | 1 | Mt | - | Estimate |
| Turkey | None | 4.5 | Bt | - | Total |
| Slovakia | None | 4.43 | Mt | economic | Verified Z1 |
| Greece | USGS | 160 | Mt | - | Indicated |
| Hungary | Russian Classification | 11.6 | Million $m^3$ | 2.08 $t/m^3$ | A+B |

## WORLD AND EU MINE PRODUCTION

The global production of perlite in 2020 slightly exceeded 4.7 Mt, while the EU distribution corresponds to about the 20% of the global production. China, Turkey, Greece, US and Iran are the major producing countries, but production of perlite takes place in several other countries at much smaller scale (Figure 10) (WMD, since 1984). USGS provides increased world amount production in comparison to WMD (Figure 11) since 2014 because they include China production (USGS, since 2000).

In Greece major perlite production comes from the island of Milos and in Turkey perlite is produced from the Western part of the country. Imerys S.A. is the most important supplier of perlite and the company owns important deposits both in Greece and Turkey (BGS, 2019).

Greece produces 91% of the European perlite. Other European countries producing perlite are Hungary with a production share of 1.7%, Italy with a share of 1.5%, Slovakia with a share of 0.5% and Bulgaria with a share of less than 0.1% (Figure 12).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958211

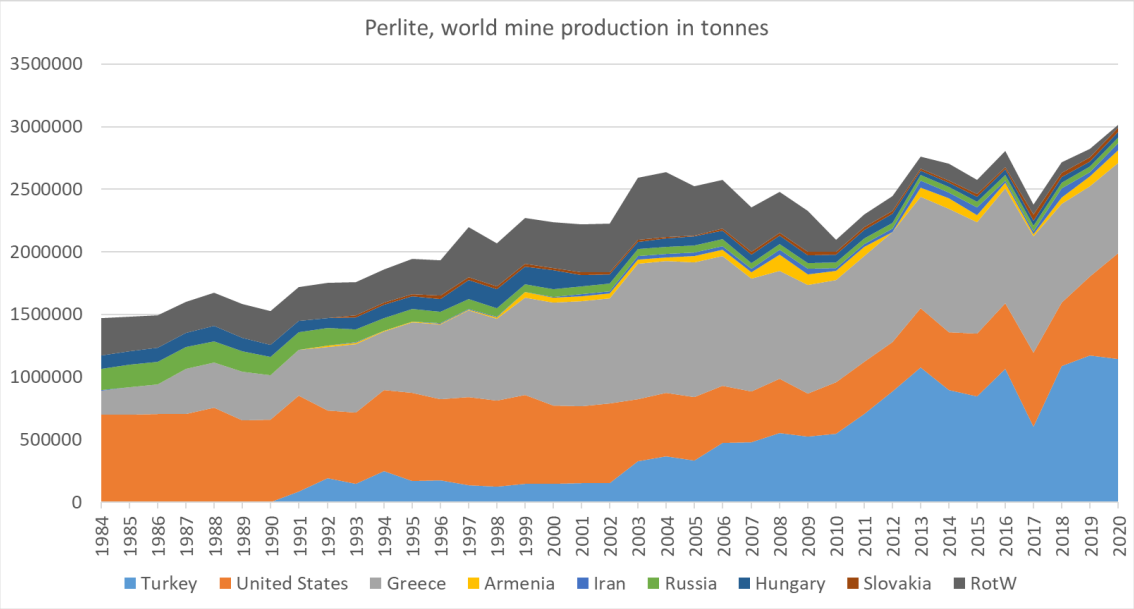


**Figure 10. Global perlite production since 1984 (WMD, since 1984).**

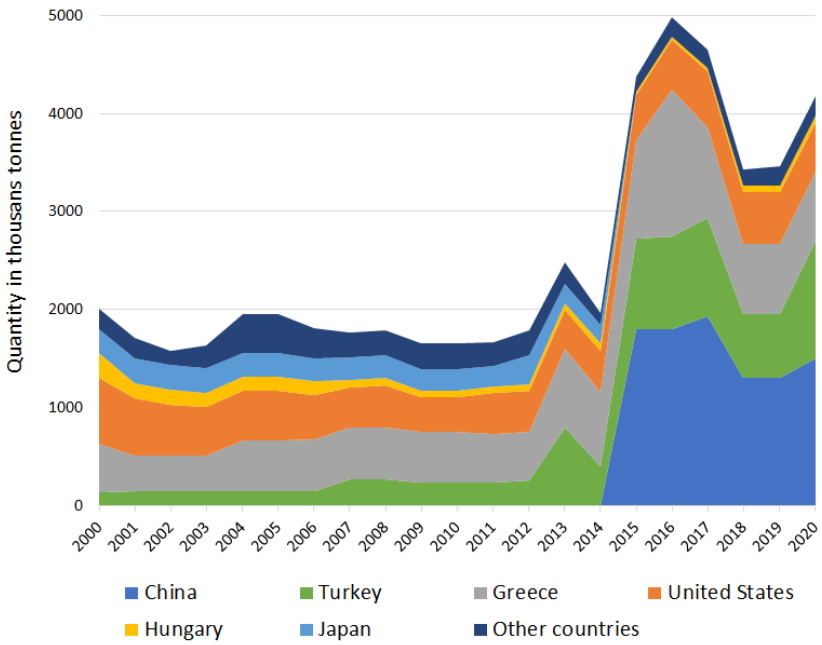


**Figure 11. Global perlite production since 2000 (USGS, since 2000).**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958211

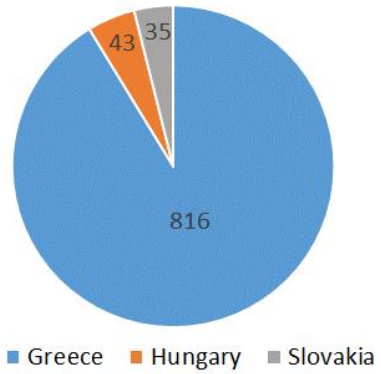


**Figure 12. Production distribution of EU countries in 2020 (amounts in thousand tonnes) according to WMD (WMD, since 1984).**

## OUTLOOK FOR SUPPLY

Perlite market is expected to grow with an annual rate of 3.5 % until 2026 due to the increased demand in building construction and pipe insulation sectors. The demand excess is expected to be covered by the expansion of perlite mining in North America

(thebusinessresearchcompany.com, 2023).

## SUPPLY FROM SECONDARY MATERIALS/RECYCLING

Perlite is not commonly recovered from waste and therefore there is no availability of perlite from secondary sources. However, construction and demolition waste, which represents the most important application for perlite, is widely recycled across the EU. The recycling of mineral-based waste in EU, based on Eurostat data, is estimated at 42%. This rate applies to all different categories of mineral-based waste, including perlite for products that finds use but not solely on perlite. There is limited literature on perlite recycling therefore the estimation of a recycling rate is not possible.

## PROCESSING OF PERLITE

Perlite is usually mined using open pit techniques. In some cases selective mining is applied to minimize the amount of rhyolite or obsidian impurities. After primary crushing, the ore is loaded to the processing plant. If the deposit is not homogeneous, or if the feed to the plant originates from different deposits, the ore is blended to produce consistent milling that can meet specific specifications. Depending on the application, the processing plant can produce two different kinds of perlite products: crude perlite or expanded. Crude perlite only undergoes particle size reduction, whereas expanded perlite is subject to calcination in order the volume of particles increase to 6 times and simultaneously a low density-high porosity material be produced. An initial particle size reducing to approximately 1.6 cm is taking place in jaw or roller crushers. After drying, the particle size is further reduced with vibratory screens, air classification and hammer or rod mills. If the intended product is expanded perlite, calcination is undertaken in rotary or vertical furnaces. The calcination temperature varies between 480 to 1160$^{o}$C. A final particle size separation is carried on using a combination

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958211

of cyclones, mills, separators and baghouses (Guatame-Garcia, 2019). Figure 13 presents the simplified flowsheet of perlite processing.

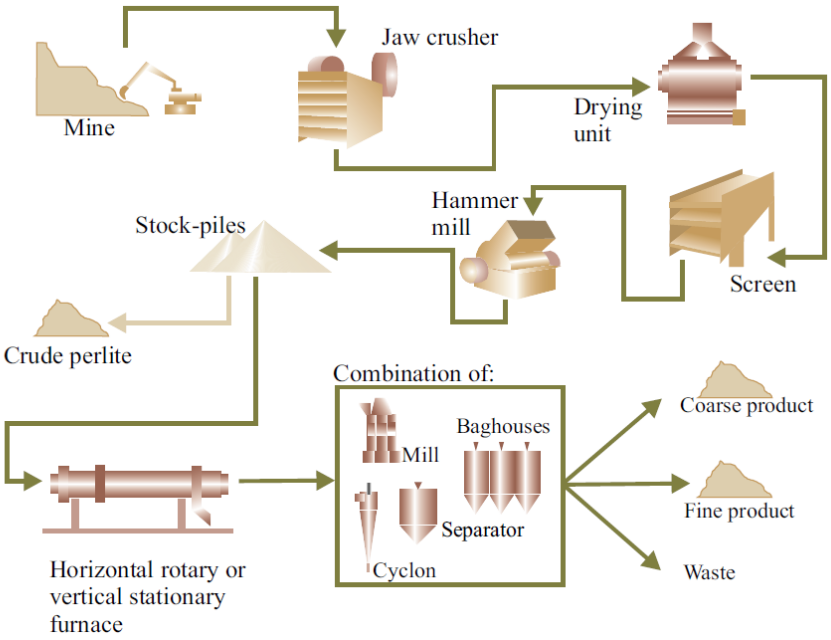


**Figure 13. Flowsheet for the processing of perlite to produce expanded perlite product (Guatame-Garcia, 2019).**

## OTHER CONSIDERATIONS

### USE AND PROCESSING OF THE MATERIAL

The International Association for Sustainable Building and Living developed Guideline 0408. The guideline defines criteria for being awarded with the natureplus eco-label for perlite boards for internal applications. The Eco-label is classified as a Type I environmental label as per ISO 14024, taking into consideration the EU Ecolabel Regulation and the EMAS regulation on environmental auditing, and is valid across the whole of Europe according to uniform criteria. The pre-requirements for a construction product to be certified with the natureplus®-Eco-label are its especially high performance characteristics in terms of the environment, health and sustainability. (Natureplus 2022)

### RESEARCH AND DEVELOPMENT TRENDS

#### RESEARCH AND DEVELOPMENT TRENDS FOR LOW-CARBON AND GREEN TECHNOLOGIES

- INNOVIP[4] project: Innovative multi-functional Vacuum-Insulation-Panels (VIPs) for use in the building sector (EU, 2016 – 2020)

[4] CORDIS EU research results: 10.3030/723441

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958211

INNOVIP researched top-of-the-line vacuum-insulation-panels (VIP) by improving their thermal performance over the entire lifetime by at least 25 % and making VIPs adjustable, mountable and machineable. By reducing the density of the core material and/or using an alternative core material together with less expensive VIP-envelopes as gas barrier, INNOVIP will be 20 % cheaper. The new product has at least 25 % less embodied energy and, attaching different cover layers, the panels can fulfill different functions. These additional functions can be adjusted according to the application they address, for example photocatalytic VOC removal from indoor and outdoor air, anti mould coating, moisture buffering by aluminium compounds or summer heat cut-off by latent heat activated in phase change materials (PCMs). In principle, the new product is ready for use in certain important and representative applications, addressing a relevant market volume by replacing conventional insulating materials and standard VIP.

- Fabrication of low-cost kaolinite/perlite membrane for microfiltration of dairy and textile wastewaters (El Machtani Idrissi et al. 2023

This work is addressing the preparation of low-cost ceramic microfiltration membrane from cheap geomaterials namely kaolinite and perlite for the clarification of dairy and textile wastewaters. The effect of sintering temperature (950–1100 °C) and perlite content (25–75 wt%) on phase transformation, porosity, mechanical strength and permeability were investigated. The resulting membrane shows a good cohesion and a high flexural strength. The optimized kaolinite/perlite membrane containing 50 wt% of perlite sintered at 1050 °C exhibits a permeability of 1779 L $h^{-1}$ $m^{-2}$ $bar^{-1}$ and an average pore diameter of 1.25 µm. More importantly, the clarification of dairy and textile wastewaters using kaolinite/perlite membrane could remove more than 97 % of turbidity of both wastewaters, and reject 45 % and 80 % of total organic carbon respectively for dairy and textile wastewaters. In addition, the flux is mostly recovered after membrane cleaning and it reaches 90.17 % and 75.23 % for dairy and textile wastewater respectively. Besides, the cost of the prepared membranes was estimated to be 7.7 $ $m^{-2}$ suggesting possible industrial scaling-up.

- Exploitation of waste perlite products in lime-based mortars and grouts (Stefanidou et al. 2023)

During industrial perlite processing, a significant number of secondary products derives and remains unexploited but causing environmental burdens. The study focuses on exploiting two secondary products (D1S and D1C) as pozzolans in the production of mortars and grouts. Nine mixtures where manufactured and tested, including five mortars and four grouts, where natural pozzolan was substituted by D1S and D1C. The fresh state properties of all mixtures were recorded, as well as their hardened ones, including shrinkage deformations, porosity, apparent specific gravity, water absorption coefficient due to capillary action, dynamic modulus of elasticity, flexure and compressive strength. From the correlation of the results, it was asserted that the partial or even total substitution of natural pozzolan by perlite secondary products, can positively influence the physical and mechanical properties of the composites. D1S seems to be an alternative pozzolanic material leading in mortars and grouts of enhanced properties. It maybe therefore concluded that the exploitation of perlite secondary products in the construction sector is feasible, leading to the development of effective, low-cost and environmentally friendly products for specific applications.

## OTHER RESEARCH AND DEVELOPMENT TRENDS

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958211

- Performance of perlite as viscosifier in manganese tetroxide water based-drilling fluid (Al Jaberi et al. 2023)

The rheological properties of drilling fluids are considered critical in mud design and selection. They greatly impact various drilling fluid functions, including the ultimate workover, carrying capacity, cuttings transportation, minimizing the loss circulation, etc. Therefore, different additives were used to control the rheological properties and improve the other drilling fluid parameters such as filtration and filter cake properties. Perlite was examined as an additive for manganese tetroxide water based-drilling fluids. Two dosages of manganese tetroxide were prepared 713 and and 999 kg/m$^3$). The rheological properties were evaluated and implemented to assess the fluid behaviour using four different models. In addition, the impact of perlite on the manganese tetroxide drilling mud at varied densities were investigated in term of pH value and the sagging tendency. The obtained results showed that adding the perlite reduced the plastic viscosity while the yield point increased. The three parameters' models including Herschel-Bulkley and Robertson-Stiff models were the best in describing the drilling fluid with and without the perlite. It was also observed that the perlite has negligible effects on pH and the sagging factor was maintained in the safe window. Moreover, the filtration and the filter cake characteristics were enhanced upon the perlite addition in both mud densities.

## REFERENCES


BGS (2014), World Mineral Production 2008-2012, [online] Keyworth, Nottingham British Geological Survey, Available at: https://www.bgs.ac.uk/mineralsuk/statistics/worldStatistics.html

BGS (2019), World Mineral Production 2014-2017, [online] Keyworth, Nottingham British Geological Survey, Available at: https://www.bgs.ac.uk/mineralsuk/statistics/worldStatistics.html

CRM experts (2022), SCRREEN Experts Workshop on Platinum Group Metals. Brussels: 22.09.2022

Eurostat (2021), Annual detailed enterprise statistics for industry (NACE Rev. 2, B-E), https://ec.europa.eu/eurostat/en/web/products-datasets/-/SBS_NA_IND_R2 , accessed on December 2021

Eurostat Comext (2022), Eurostat database. EU trade since 1988 by HS2-4-6 and CN8 (DS-045409). , http://epp.eurostat.ec.europa.eu/newxtweb/ , accessed on December 2022

Evans, A. M. (1993), Ore Geology and Industrial Minerals. An Introduction. Third Edition Oxford and Northampton Blackwell Science

Guatame-Garcia, A. (2019), Detection of factors that determine the quality of industrial minerals. An infrared sensor-based approach for mining and process control, Proefschrift, Delft University of Technology.

Kogel, J. E., Trivedi, N.C., Barker, J.M., Krukowski, S.T. (2006), Industrial Minerals & Rocks. Commodities, Markets, and Uses. 7th Edition. SME.

Minerals4EU (2019), European Minerals Yearbook. [online] Available at: http://minerals4eu.brgm-rec.fr/m4eu-yearbook/theme_selection.html

Patel, K. and A. Torrisi (2014), A growing market: vermiculite and perlite in horticulture.

Perlite Institute (2022), Applications of perlite [online] Available at: https://www.perlite.org/



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958211

thebusinessresearchcompany.com (2023), available at: https://www.thebusinessresearchcompany.com/report/perlite-global-market-report, accessed in January 2023.

United States Environmental Protection Agency (1995), AP 42, Fifth Edition, Volume I Chapter 11: Mineral Products Industry - Perlite. [online] Available at: https://www3.epa.gov/ttn/chief/ap42/ch11/index.html

USGS (2019), Perlite (2019), https://d9-wret.s3-us-west-2.amazonaws.com/assets/palladium/production/atoms/files/mcs-2019-perli.pdf, accessed on December 2022

USGS (2022), Mineral Commodity Summaries, https://www.usgs.gov/centers/national-minerals-information-center, accessed on December 2022

USGS (Since 2000), Mineral Commodity Summaries, U.S. Department of the Interior, U.S. Geological Survey

WMD (2022), Federal Ministry of Agriculture, Regions and Tourism of Austria (Ed.): World Mining Data (since 1984).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958211