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Based on a Large Solar Device Technological Features of Selection of Local Raw Materials

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Abstract: This article highlights the features of selecting local raw materials for obtaining heat-resistant ceramic tiles made on the basis of a large solar furnace. A technical description of the substances contained in the amesite mineral of the serpentine in the Kumushkon mountains of the Tashkent region is presented.

Keywords: Incarnate solar rays, large solar furnace, serpentine, amesite, thermal decomposition.

Introduction.

Serpentine was selected from ceramic materials based on local raw materials and the crystal structures of its minerals were studied. Serpentine contains the following minerals : MgO — 43.0%; H_2O — 18.9%; SiO_2 — 44.1% . The crystal structure of the substances in the serpentine mineral is shown in Figure 1, and its technical characteristics are given in Table 1.

Serpentine. Serpentine deposits are found in the Urals, Siberia, Kazakhstan, the North Caucasus, New Zealand, India, Cuba, Italy, Mongolia, Afghanistan, and the Kumushkan Mountains of the Tashkent region.

Serpentines are dense masses that do not form crystals. Sometimes they have a foliated or fibrous structure (chrysotile asbestos). Dense serpentine of uniform color and light color, often transparent, is called genuine serpentine and is used as an ornamental stone. Its color, from greenish-yellow to dark green, and its resemblance to snakeskin, give it the name serpentine. They are formed in the weathering crust of ultramafic rocks. At temperatures above 400-450 ^{0}C, serpentine turns into talc and forsterite, and during chemical weathering into palyagorskite, sepiolite and montmorillonite.

Methodology.

The chemical formula of the mineral is given as follows.

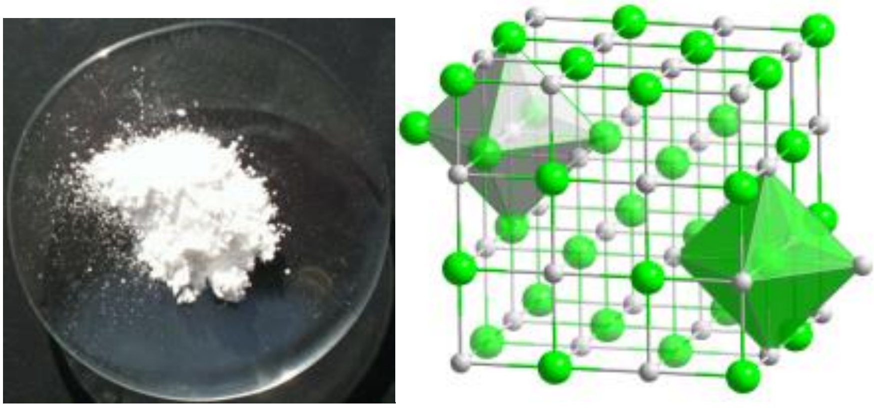
$X_{2-3}Si_2O_5(OH)_4$ (1)

where X = Mg, Fe^{2+}, Fe^{3+}, Ni, Al, Zn, Mn. There are several types of serpentine minerals, these are listed in Table 2. Amethyst types found in the Kumushkan Mountains were taken for research.

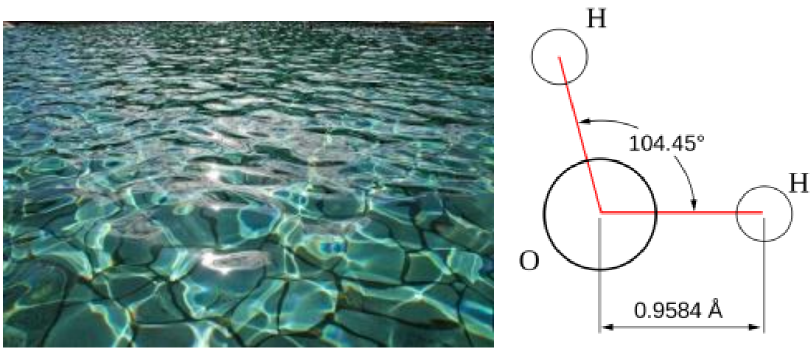
The component ratio varies slightly, especially in the case of typical colloid-like variations (usually 13-17%), FeO, Fe_2O_3 and NiO are almost always present in the form of mixtures. The melting point of serpentine is 650 ^{0}C. When melting serpentine, it should not be affected by artificial external environments, i.e., immersion of the molten material in water, cooling with cold air, which leads to internal defects in the material.

Table 1.Technical description of the substances in the serpentine mineral.

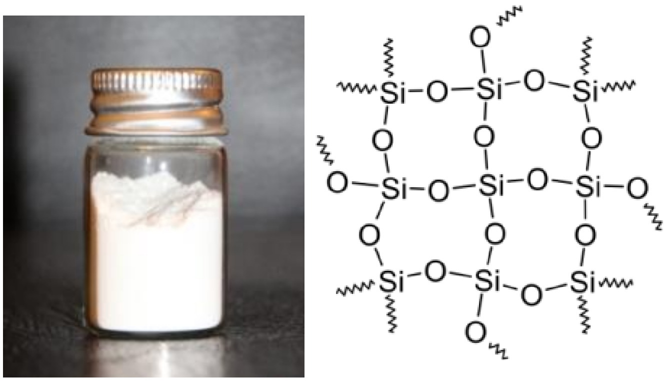
Technical description of MgO	
General	
Regular name	Magnesium oxide
Traditional names	Burnt magnesia lipopericlase
Chemical formula	MgO
Physical characteristics	
Status	Hard
Molar mass	40.3044g/ mol
Density	3.58g/cm³
Thermal properties	
Melting temperature	2825 ^{0}C
Boiling temperature	3600 ^{0}C
Mol heat capacity	601.8k J /mol
Vapor pressure	0±1mm .sym.set. [1]
Chemical properties	
Solubility in water	0.86 g/100 ml
Classification	
Standard storage conditions	25°C, 100kPa
Technical description of H_2O	
General	
Regular name	Hydrogen oxide
Traditional names	Water
Chemical formula	H2O
Physical characteristics	
Status	Liquid
Molar mass	18.01528 g/ mol
Density	0.9982 g/cm³
Thermal properties	
Melting temperature	273.1 K (0 °C)
Boiling temperature	373.1 K (99.974 °C)
Mol heat capacity	75.37 J /mol K
Classification	
Standard storage conditions	25 °C, 100 kPa
Technical description of SiO_2	
General	
Regular name	Silica (IV)
Traditional names	Silica
Chemical formula	SiO_2
Thermal properties	
Melting temperature	1600 ^{0}C
Boiling temperature	2950 ^{0}C
Vapor pressure	0±1mm .
Classification	
Standard storage conditions	25°C, 100kPa



(a) MgO powder and crystal structure.



b) H_2O and its crystal structure.



c) . SiO_2 powder and crystal structure.

Figure 1. Powder and crystal structure of serpentine mineral.

Table 2.Types of serpentine mineral.

Name	English name	Chemical formula
Antigorite	Antigorite	$(Mg,Fe)_3Si_2O_5(OH)_4$
Lizardite	Lizardite	$Mg3Si2O5_{(OH)}4$
Clinochrysotile	Orthochrysotile	$Mg3Si2O5_{(OH)}4$
Orthochrysotile	Orthochrysotile	$Mg3Si2O5_{(OH)}4$
Parachrysotile	Parashrizotile	$Mg3Si2O5_{(OH)}4$
Caryophyllite	Caryophyllite	$(Mn,Mg,Zn,Fe)_3(Si,As)_2O_5 10(OH,Cl)_4$
Grenalite	Greenalite	$(Fe, _{Fe})_{2\text{-}3Si2O5}(_{OH})_4$
Berthierin	Berthierine	$(Fe,Fe,Al,Mg)_{2\text{-}3}(Si,Al)_2O_5(OH)_4$
Freipontite	Fraipontite	$(Zn, Al)_3(Si, Al)_2O_5(OH)_4$
Zinalite	Zinalsite	$Zn_2AlSi_2O_5(OH)_4 2(H_2O)$
Doziit	Dozyite	$(Mg_7Al_2)(Si_4Al_2)O_{15}(OH)_{12}$

Amethyst	Amesite	Mg2Al (SiAl)O5 $_{(OH)}$) $_4$
Kelly	Kellyite	(Mn,Mg,Al) $_3$ (Si,Al) $_2$ O $_5$ (OH) $_4$
Kronstadt	Cronstedtite	Fe2Fe (SiFe)O5 $_{(OH)}$) $_4$
Karpinskite	Karpinskite	(Mg,Ni) $_2$ Si $_2$ O $_5$ (OH) $_2$
Nepuit	Nephew	Ni3Si2O5 $_{(OH)}$) 4
Pecoraite	Pekoraite	Ni3Si2O5 $_{(OH)}$) 4
brindleyite (nimesite)	Brindleyite	(Ni,Mg,Fe) $_2$ Al(SiAl)O $_5$ (OH) $_4$
Maufit	Maufite	(Mg,Ni)Al $_4$ Si $_3$ O $_{13}$ 4(H $_2$ O)
Carlosturanite	Carlosturanite	(Mg,Fe,Ti,Mn) $_{21}$ (Si,Al) $_{12}$ O $_{28}$ (OH) $_{34}$

Silver serpentine is a mineral of the layered silicate subclass.

Mg3 [$_{Si2O5}$] $_($ OH) $_{4(}$ 2)

Yellowish, brown-green cryptocrystal, hardness up to 3.5 times its mass; different types: optical (dense, transparent decorative stone), antigorite (scale, shell), chrysotile asbestos (fibrous). Formed as a result of hydrothermal alteration of ultrabasic rocks. The process up to 700 ^{0} C refers to a low temperature. Thermal decomposition (dehydration) of serpentine, according to X-ray data, ends at 700 $^{0\ C.}$ 35% to 70% magnesium oxide, 5% to 25% magnesium chloride, and 20% to 40% water. When the flow rate of magnesium chloride solution is less than 36%, it can be seen that the change of magnesium chloride content in both directions reduced the mechanical strength of the sample. With an increase in the amount of solution, the mechanical strength increases to 80 kg / cm ^{2} if the concentration of magnesium chloride is higher than 58% . Considering the variability of the volume formed as a result of the increase in magnesium chloride, it can be called an optimized ratio.

Conclusion.

In conclusion, this investigation into the technological features influencing raw material selection for a large-scale solar device underscores the critical interplay between performance optimization and localized resource utilization. While prioritizing high energy conversion efficiency often necessitates advanced materials, the study reveals a compelling case for leveraging locally sourced alternatives, where feasible, to reduce transportation costs, minimize environmental impact, and bolster regional economies. The findings suggest that specific technological adaptations, such as modified manufacturing processes or innovative material combinations, can enhance the suitability of local raw materials for solar device construction without significantly compromising performance metrics. The implications extend to promoting sustainable development in regions with abundant, underutilized resources, while encouraging technological advancements that prioritize circular economy principles and reduce reliance on globally sourced materials. Future research should focus on developing cost-effective refining techniques for locally sourced materials, exploring novel composite materials that integrate local and imported components, and conducting comprehensive life-cycle assessments to quantify the environmental and economic benefits of prioritizing local resource utilization in large-scale solar deployments.

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