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GENESIS OF A VOLCANIC INDUSTRIAL ROCK, TRACHILAS PERLITE DEPOSIT, MILOS ISLAND, GREECE

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ABSTRACT

Geological mapping, mineralogical and geochemical observations on Trachilas perlites shed new light on the genesis and the nature of this useful industrial rock.

The perlite deposit was produced after the last eruption (hydroclastic eruption) of Trachilas volcano. After the deposition of sand, ash, perlitic and older lava fragments formation, the perlite was formed, giving a lahar of perlite and perlite beds (hard, classical, and pumiceous perlites). Clays form the last horizon. Finally a perlitic dome penetrated the previous perlitic succession.

The perlite consists of quartz, feldspars, biotite, opaque minerals, vesicles, and glass. Various textures are identified ranging from the hard perlite texture to the pumiceous one. The proportion of vesicles increases and glass decreases from the hard to the pumiceous perlite, indicating the hydration of glass.

Geochemically, the Trachilas perlites have the same chemical composition, differing only in their absorbed water content. They are rhyolitic rocks, rapidly cooled by intersecting a ground water horizon which formed the glass.

INTRODUCTION

Greece is the largest western european producer and exporter of perlite. It is the third perlite producer worldwide, after United States of America, and Russia. The most commercially important deposits occur on the island of Milos,(Achivadolimni (Provatas) and Trachilas areas), and to a lesser extent on Kos island. Other smaller deposits occur on Kimolos and Lesvos islands, and on the Greek mainland (Thrace and Macedonia).

Perlite is a volcanic glass of rhyolitic composition, containing 2 to 5 per cent of combined water and characterized by a system of concentric, spheroidal cracks, called perlitic structure.

In a commercial sense the term perlite is also used to describe any glassy volcanic rock which has the ability to expand to about 20 times its volume when quickly heated to a temperature above its softening point and form a light-colored, lightweight, frothy material.

Trachilas perlite deposit on Milos island is a typical example of the occurrence and genesis of this industrial rock. Careful sampling, detailed mapping, mineralogical and geochemical observations can provide information on the genesis of the perlite deposit.

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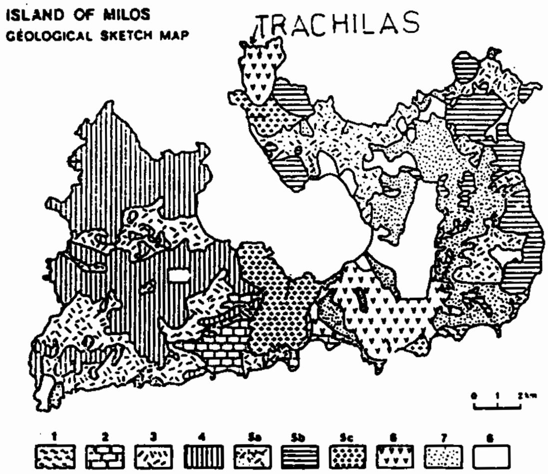


Fig. 1: Geological Map of Milos island (Fytikas et al, 1986). 1=Metamorphic basement, 2=Neogene sediments, 3=basal pyroclastic series, 4.=complex of domes and lava flows, 5=pyroclastic series and lava domes, 6=rhyolitic complexes of Fyriplaka and Trachilas(where perlites occur), 7=products of phreatic activity, 8=Quaternary sediments.

GEOLOGY

Three main geological units can be distinguised on Milos island, according to Fytikas (1977) : a crystalline basement, the Neogene sedimentary series and a complex of Quaternary volcanic products (Fig. 1).

The crystalline basement consists of para- and ortho- metamorhic rocks. The Neogenic sedimentary series are dated as Miocene-Lower Pliocene age and overlie the crystalline basement. Three series of volcanics can be distinguised, starting in the Upper Pliocene : 1. the oldest series of pyroclastic rocks, pumice flow deposits, subaerial tuffs and shallow marine tuffites, which are followed by the deposition of ignimbrites, and finally the younger lavas (andesitic to rhyolitic composition), tuffs, pyroclastics and conglomerates. 2. the Lower Pleistocene volcanic-pyroclastic series which consists of lava domes and Halepa and Plakes domes. 3. the last volcanic episode of rhyolitic composition occurs in the Fyriplaka and Trachilas areas,where the perlite deposits have present.

The remains of Trachilas volcanic centre, which erupted 0.38 m.y. ago (Fytikas et al., 1986) still exist, although the northern part of the crater has been destroyed. The depth of the crater is less than 100m. Its diameter should be 900m.

Nine different volcanic products have been recognized in the field (Fig. 2):

1. The clays (Paleosoil) form the upper formation of the Trachilas stratigraphic column, and contains clays and few fragments of dacite. It is a poorly consolidated formation, easily removed by erosion, and appears in only two small places in the Trachilas area (Plate 2).

2. The lahar of perlite contains fragments of perlite in clay flows, covers the most of Trachilas area, and is produced by strong eruption of the volcano after/or during the deposition of the perlite (Plate 2).

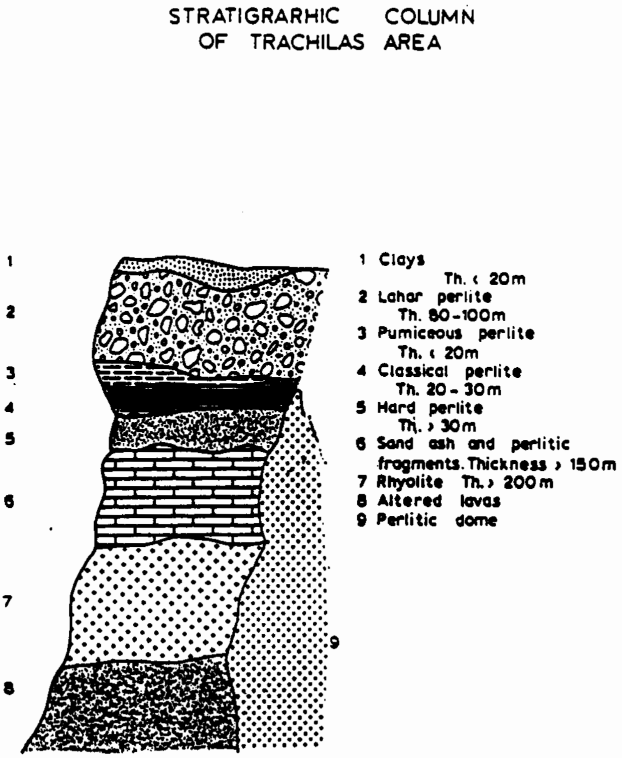
3. The pumiceous perlite is recognized in the field because of its lightweight and frothy features, and is present only in the mine (Plate 2).

4. The classical perlite is denser than the pumiceous perlite, and appears in contact with the hard and the pumiceous perlites in the mine.

5. The hard perlite is denser than the previous perlites, having a reddish colour, and appears only in the Kerdari Cap.

6. The sand, ash and perlitic fragments contains coarse sand and ash, few fragments of older lavas, and perlitic lapilli. It occurs in reversely gradded and unconsolidated layers. The formation covers only a small area, close to Firopotamos Bay (Plate 1). It was deposited by the first explosion of Trachilas volcano, before the perlite deposition.

7. The perlitic dome appears in the field in a conic shape and penetrates into the perlitic succession and the lahar of perlite, has a reddish colour and



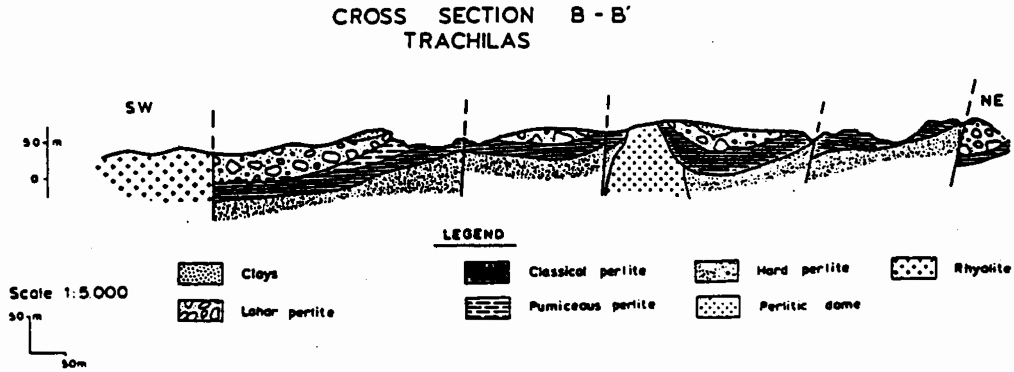


Fig. 2: Stratigraphic column and cross section of Trachilas deposit.

is denser than all the perlites. It is present only in the eastern parts of the mine. It is younger than the perlitic succession.

8. <u>The rhyolite</u> covers the western parts of Trachilas area, having a tectonic contact with the perlites. The rhyolite is older than all the perlites.

9. <u>The altered lavas</u> are older than the rhyolite and the perlites which have been altered by the complex of faulting systems, and are white to yellow in colour, presented close to Firopotamos Bay.

The Trachilas volcano lies at the southern end of Trachilas peninsula. Its products cover the remainder of the peninsula to the north, a distance up to 3 km.

MINERALOGY

All the perlite rocks have the same mineral composition; quartz, K-feldspar, plagioclase, biotite, opaque minerals, vesicles, and glass.

Six different textures have been distinguished under the microscope : 1. Hard perlite texture, 2. Classical perlite texture, 3. Glassy perlite texture, 4. Vesiculated perlite texture, 5. Pumiceous perlite texture, 6. Clay texture.

The correspondance of the textures with the perlites found in the field are given in Table 1.

Table 1: The correspondance of the textures with the perlites

Hard perlite	Hard perlite texture
Classical perlite	Classical perlite texture
	Glassy perlite texture
	Vesiculated perlite texture
Pumiceous perlite	Pumiceous perlite texture
Lahar of perlite	Clay texture

The following characteristics can be observed in each category:

1. The hard perlite texture is very dense texture, including few vesicles in the groundmass.

2. The classical perlite texture is characterised by perlitic cracks; spheroidal cracks in the glass (Plate 3).

3. The glassy perlite texture is very similar to the classical one, but has more vesicles and presents an elongated, non spheroidal structure in the glass.

4. The vesiculated perlite texture is similar to the glassy perlite texture, with even more vesicles, without presenting the elongated glassy structure.

5. The pumiceous perlite texture is visible both in the section and the field. Vesicles form the major part of the rock, giving it a frothy appearance (Plate 3).

6. The clay texture is derived from perlitic samples found in the lahar of perlite. The texture is very dense because of the abundance of clays in the perlitic structure.

Table 2: Mean quantitative analyses (%) of Trachilas perlites

Texture	Qtz	K-fd	Plg	Biot	Opaq	Glass	Ves
Hard	11.2	4.0	0.6	2.0	3.0	79.2	–
Classical	13.8	2.6	2.0	2.9	0.9	74.9	2.6
Glassy	6.9	1.8	2.6	2.5	1.0	74.7	10.1
Vesicul	7.4	3.0	2.0	3.0	1.6	63.0	20.0
Pumiceous	5.7	1.3	1.4	0.6	–	28.3	62.4
Clay	6.8	1.2	5.3	1.4	1.8	71.6	12.0

The quantitative mineralogical composition identified in each perlitic texture, as a result of point-counting thin section, is given in Table 2.

The data indicates the increase of vesicles and the decrease of the glass going from the hard, classical perlite, through the glassy and vesiculated ones to the pumiceous perlite.

The pumiceous perlite has decreased in the quartz, biotite, and opaque minerals, but still have similar feldpars proportion with the rest of perlites.

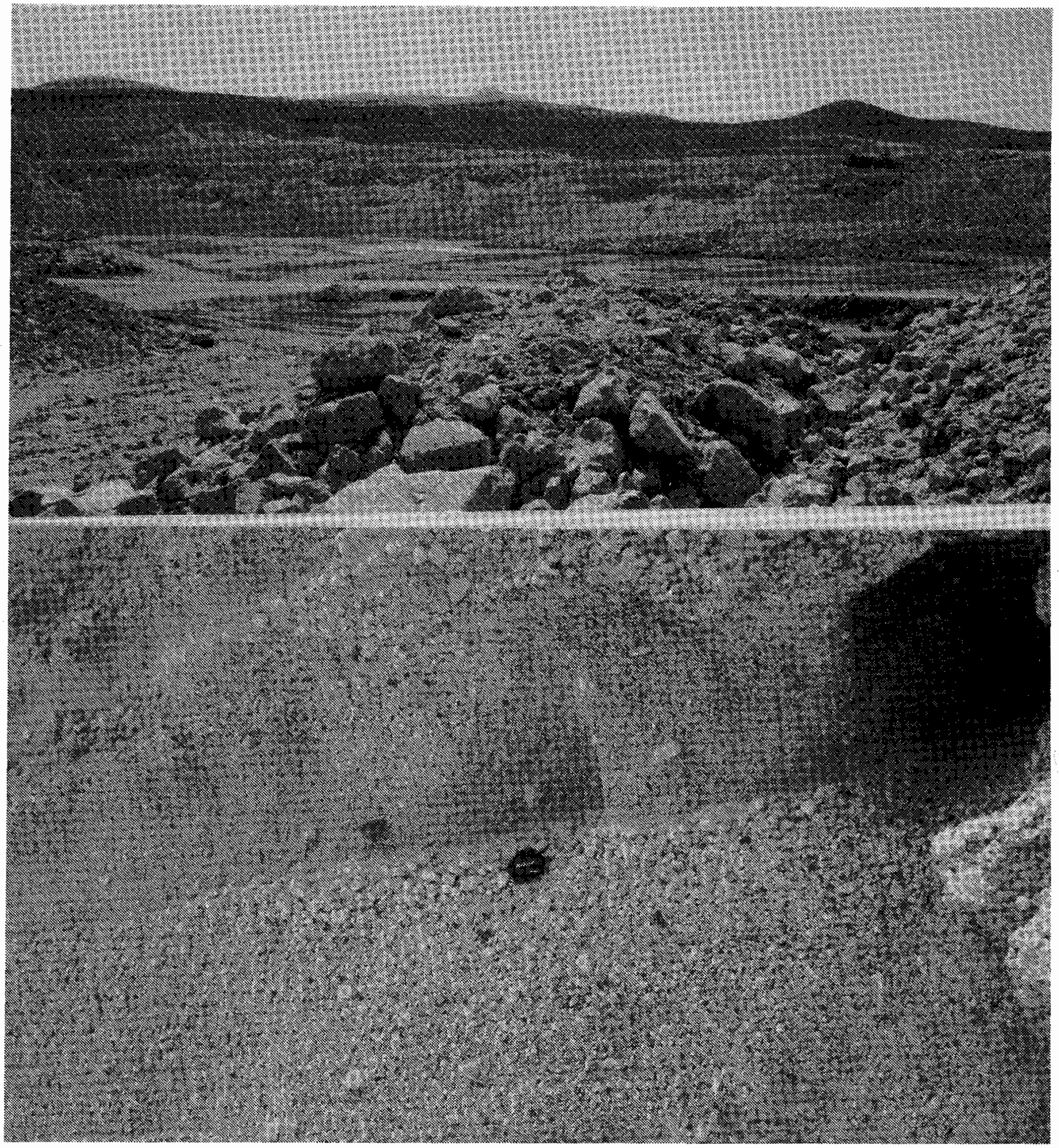


Plate 1: View of Trachilas mine and sand, ash, and perlitic fragments formation.

CHEMICAL ANALYSIS

The composition of 26 samples of the different type of perlite has been determined by X-ray fluorescence analysis. Typical analyses of each type are shown in Table 3.

The major element analysis of perlite samples indicate that there is no great variance in the chemical composition of the different types of perlite in Trachilas deposit.

The bulk chemistry indicates that the rocks are rhyolites.

The loss on ignition is almost the same for all the perlites, approximately 2 to 3 per cent, except of the hard perlite which has 3.32%.

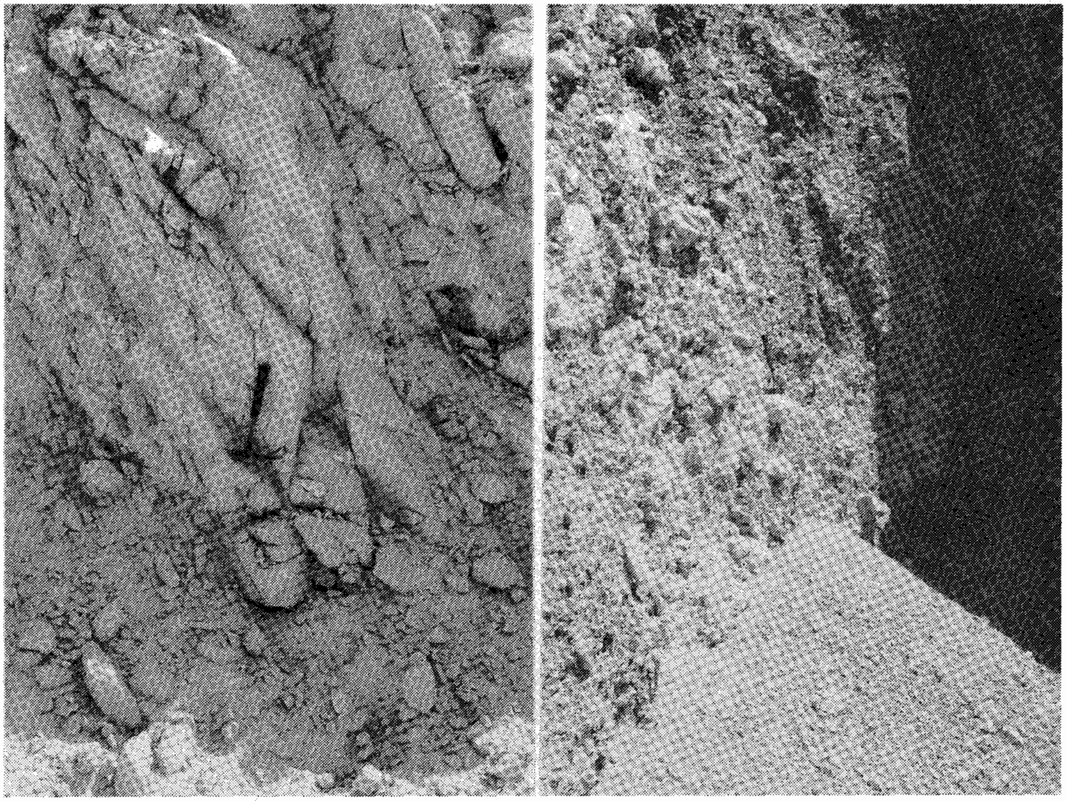


Plate 2: Pumiceous perlite (left) and the contact between lahar of perlite and clays(right).

Table 3: Chemical composition of Trachilas perlites

	Hard	Class.	Glas.	Vesic.	Pumic.	Clay
SiO2	74.27	75.18	76.30	76.22	74.77	76.62
TiO2	0.09	0.08	0.08	0.08	0.09	0.10
Al2O3	12.22	11.49	11.72	11.83	12.26	11.79
Fe2O3	0.91	0.96	0.94	0.93	0.88	1.07
MnO	0.09	0.08	0.08	0.08	0.09	0.08
MgO	0.18	0.22	0.20	0.17	0.11	0.21
CaO	0.72	0.73	0.72	0.70	0.72	0.81
Na2O	3.81	3.09	3.14	3.25	3.36	2.93
K2O	4.66	4.51	4.52	4.51	4.58	4.52
P2O5	0.03	0.02	0.02	0.02	0.02	0.03
L.O.I	3.32	2.73	2.24	2.37	2.90	2.20
Total	100.28	99.08	99.96	100.16	99.76	100.35

DISCUSSION-CONCLUSIONS

The geological history of Trachilas volcanic products can be deduced from the field observations of the area and their mineralogical and geochemical features.

Rhyolite was deposited after older lavas which are very altered.

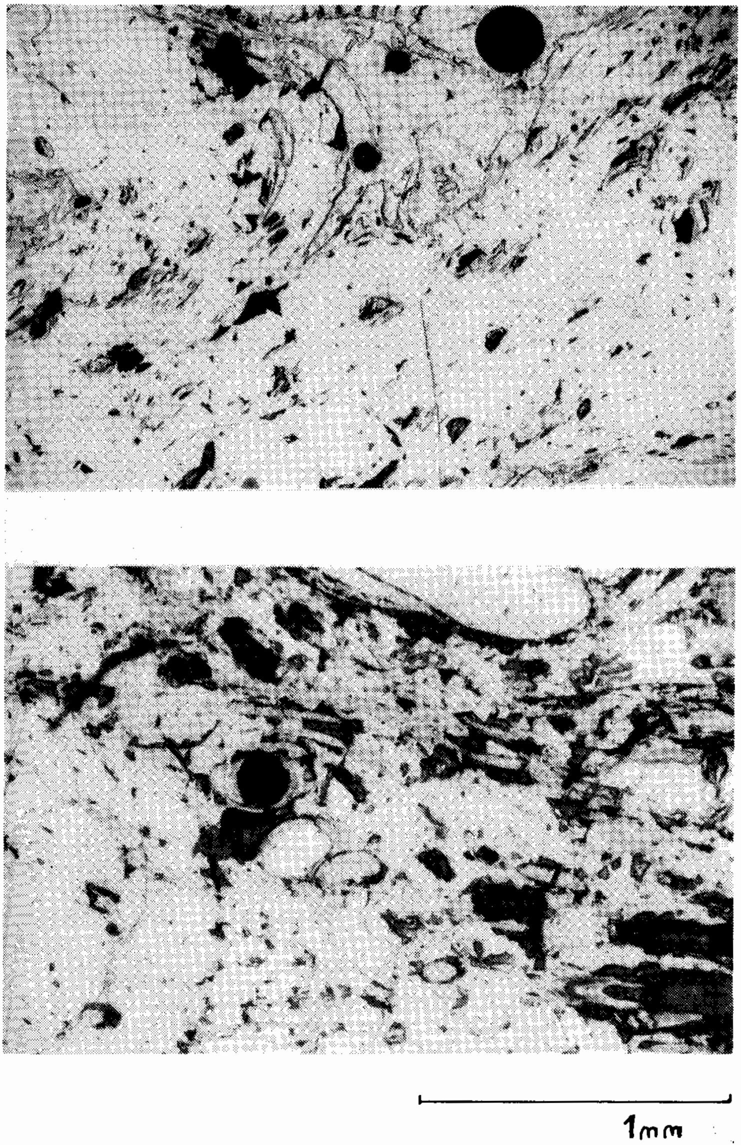


Plate 3: Classical (above) and pumiceous perlite (below) under the microscope.

First of all, sand, ash, perlitic and older lavas fragments formation was deposited. Secondly, the main eruption produced the perlite deposits in two forms. 1. Lahar of perlite, after the fragmentation of the erupted lava when the hot upcoming magma reached the water level, and 2. perlite beds, produced by slow cooling eruption of the magma, followed by devitrification. Then the perlitic dome, younger than the perlites, penetrated into the perlitic succession. Finally, clays (paleosoil) were deposited making the end of Trachilas volcano's activity.

The formation of Trachilas volcanic products is made by a hydroclastic eruptive process. The hydroclastic process involves the cooling of the magma followed or accompanied by fragmentation (Fischer and Schmincke,1984). The cooling of the magma was very rapid, because the ascending magma intersected the ground water horizon, and a supercooled liquid and then a solid amorphous substance, which is the glass, formed.

The chemical composition of the magma was rhyolitic, producing a high magmatic volatile content, and high viscocity volcanic products. The similarity in the chemical analysis of the various perlites indicates the origin of the perlites from the same erupted magma.

The mineralogical composition of the perlites shows the hydration process which took place after the deposition of the lavas. The hydration of the glass distinguised perlite textures from the hard perlite texture to the pumiceous one. Similar results after microscopic observations on No Agua perlite deposit, New Mexico are given by Whitson (1982).

Trachilas volcano belongs to the Tuff ring type of the Maar volcanoes, having a low volcanic cone with bowl-shaped crater. Tuff rings are formed when magma comes near to the surface before being explosively fragmented (Francis,1993).

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