W H I T E P A P E R

Pumice and Perlite

A Functional Comparative for Horticultural and Greenscaping Applications

*Top: Watercress seedlings thrive in an aquaponics system using pumice media. **Above**: Composted garden soil conditioned with a 1/8 fines grade pumice. **Below**: Pumice in a 1/8 fines grade, meaning a top particle size of 1/8 inch down to powdery fines. **Bottom**: Pumice crushed and screened to a grade #10.*

EXPANDED PERLITE is a horticultural mainstay: widely useful, wonderfully effective, tried and true. But it's wise to be aware of the functional alternatives to perlite—especially in situations when expansion facilities can't meet extensive demand surges in the market or when large-scale engineered soil constructs or native soil conditioning projects demand a more economical amendment.

So, does perlite have a sustainable, frothy-charactered, equivalent? Something that functions as a highly effective soil amendment and as a soilless grow media? Something naturally-occurring, lightweight, and water-retentive? Something that lightens heavy soils and facilitates drainage—yet doesn't break down over time and under traffic like organic amendments do? Yes. Pumice.

Characteristics of an Ideal Physical Soil Amendment

Any discussion of an ideal soil amendment must start with a look at the characteristics of an ideal growing media. That means meeting three base functions. One: provide physical support with enough porosity to allow root growth and gas exchange (aeration). Two: the ability to absorb and store water. Three: the capacity to both supply and facilitate mineral nutrient uptake by plant roots. No single material meets every criteria, so high-performance soils and grow media are made up of several complimentary components, which work together to deliver on the performance ideal—including water-holding capacity, aeration, porosity, bulk density, pH balance, cation exchange capacity, and fertility. That is typically achieved with a combination of the organic and inorganic components.

Inorganic components, like pumice and expanded perlite, contribute no nutrients to the soil (beyond providing a stable scaffolding for soil microbe colonies), but rather provide an enduring structural component to the mix design. Organics, like peat and composts, provide both nutrients and physical amendment. Until they don't. The physical soil structure improvements provided by organics do not endure. As the organic components are consumed, the important physical support they provide is lost. The soil structure collapses. Which means inorganic soil amendments are a functional must for the specialized, carefully-engineered soils needed for high-yield horticulture as well as other long-lived greenscaping needs[1]—from turf fields to ecology embankments and bioswales to shallow roof gardens to renewing blighted brownfields.

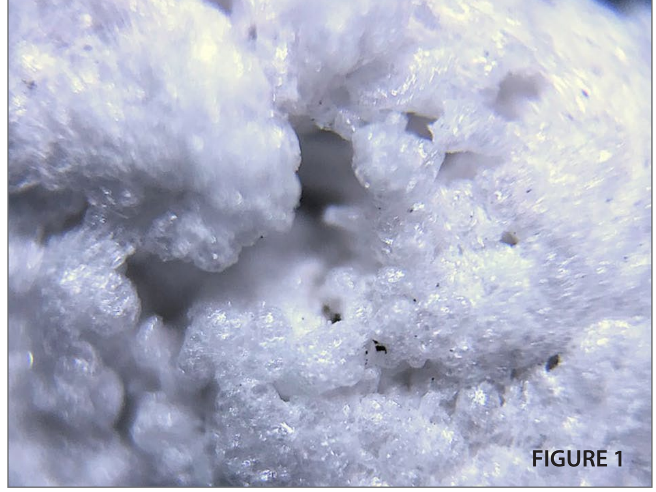
As an inorganic soil component, the foamed stone character of pumice and perlite provide several key advantages: long-term durability, light in weight and density, chemically inert, pH neutrality, cation exchange capacity, grippy surface, grade size options, performance consistency, bulk availability, sustainability. Such a performance package, native to each frothy bit and spread through the soil matrix, provides powerful conditioning. Root-zone activity is enhanced. Water and nutrients retained. Drainage and filtration action and hydric functionality are all augmented.

Pumice vs. Perlite

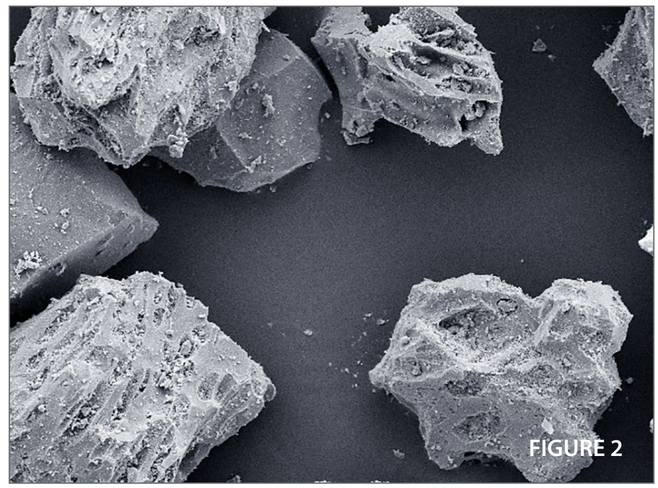
Both pumice and perlite ore (before expansion) are of volcanic origin, and deposits of both are often found close together, as is the case with the Hess deposits in Southeast Idaho. Functionally and characteristically, pumice and perlite (once it has been expanded, or "popped"), have a lot in common—especially in terms of functional value in horticulture and engineered performance-soils.

What follows is a breakdown of the most valuable character-components and other relevant aspects of an inorganic soil amendment, with an advantage determination assigned (if any) to either pumice or expanded perlite.

Physicochemical Structure. There is no performance drop using pumice instead of perlite for potting soils or to amend poor native soils. Both have a foamed-stone nature that is ideally purposed to condition soils. A University of Illinois research project[2] studied pumice as a perlite substitute for containerized growing. Specifically, the chemical properties and surface characteristics were compared. They proved analogous,



__Above__: Extreme close up of expanded perlite. __Below__: #2 grade pumice at 100x magnification. __Bottom__: Extreme close up of the surface of a pumice stone from the Hess deposit.



with pumice exhibiting a greater pore size span. The report summary states: "Pumice and perlite were shown to have similar physicochemical properties which subsequently translated into similar behavior in blended soil mixtures. It proved equally, if not even more effective in some ways, than perlite. A subsequent companion plant growth study (not reported herein) further confirmed the suitability of pumice as a soil amendment. Plants grew equally well in pumice and perlite media." Advantage: Either.

Form Factor. Non uniform in shape. Grippy surface. Lightweight. On a micro level, pumice stones and expanded perlite particles are frothy in form factor yet, being amorphous silica glass, do not absorb moisture to the point of swollen sogginess. Under magnification, the perlite form factor is revealed as tiny fused bubble clusters [FIG1]. Pumice is more sponge-like in appearance, riven with holes and hollows of various sizes and shaped by angular planes and sharp edges. Pumice is very friable by nature, meaning it retains its functional form even when crushed to small grains [FIG2]. That grippy, multi-edged, hole-pocked form factor also makes pumice a good blender in native soils or with soilless components like coir, peat, and compost—binding with other soil particles to stay firmly suspended it the soil matrix. Advantage: Either.

Amendment Economics. Pumice is a frothy volcanic stone that was born useful: because it is naturally calcined (heated and expanded) by explosive volcanic events, it is functionally ready right out of the deposit. Hence, in the horticultural grades, the cost between plant-processed and bagged pumice and expanded and bagged perlite (at pallet quantities) is roughly fifty-percent more for perlite. For multi-ton production runs of bagged commercial potting mixes, pumice comes in at an attractive price point. As for large-scale soil amendment projects and extensive turf management applications requiring truckloads of conditioner, the economics of pumice becomes exceptionally attractive. Advantage: Pumice.

The Non-Consumable, Inorganic Role. The organic amendments tout functionality in terms of water retention, heavy-soil busting, lightweight form factor, compaction resistance, sustainability (sometimes), but all have a major failing: they break down and functionally dissipate. Pumice and perlite are not consumed and so provide in-soil functionality on an indefinite time scale. That may not matter for annual flower and vegetable beds or those who frequently re-pot, but long-lived functionality does matter for build-and-done horticultural and landscaping applications—green roofs, bioswales, raised gardens, turf applications, reclamation projects. Which is why specialized soil designs call for both organic and inorganic components to meet the ideal. Advantage: Either.

Neutral pH. Pumice and perlite have a neutral pH, so there is no need to compensate for them in the acid/alkaline equation. Advantage: Either.

Bulk Densities. Pumice holds a bulk density advantage over expanded perlite. The added weight resists hydraulic lift (floating up onto the soil surface) from repeated waterings. That bulkiness also provides enhanced support when growing in shallow containers and with anchoring shallow-rooted plants like succulents and bulbs (geophytes). For tall, top-heavy plants grown in containers, the added bulk of pumice can help stabilize the pot. Advantage: Pumice.

Lightweight. In the fly-weight class of soil amendments, expanded perlite holds the title belt. Advantage: It Depends. If engineering the lightest soil possible, expanded perlite is the choice. But if bulk is wanted to provide a bit more substance and hold to the limited-depth roof garden or container or to add durability and brawn to an ecology embankment or the run-off filtering bioswale, then pumice gets the nod.

Toughness. Expanded perlite has a delicate, airy structure—a pea-sized bit of perlite can be crushed to dust between the fingers. That's not happening with a pumice nugget. The more robust structure of pumice allows it to hold up in mechanical blending and placement processes and, once in the soil, under heavy loads. The particle-erosion and breakage that can occur in-bag during shipping and handling is less evident with pumice—fewer new fines, less dust, negligible shift in grade-blend balance. Advantage: Pumice.

Water Retention and Drainage. Pumice and perlite retain moisture (by virtue of their physical structure) in three ways— 1) held within the tiny-to-microscopic pores inherent in the foamed-stones, 2) caught and held on the rough, irregular surfaces, and 3) trapped and suspended in the spaces between the tiny stones themselves. This moisture-retentive character is ideal for controlling drainage rates. One simply adjusts the particle size blend to dial up the desired drainage rate and achieve the right balance—hold enough moisture for plant use, while providing the vital aeration spaces used by root systems to expel and absorb gasses.

A Turkish study[3] looked to determine the effectiveness of pumice amendment (at various levels, using different grades) in growing strawberries. The focus was on suitability for amending aeration, drainage, and water-retention capacity by alleviating compaction and sustaining porosity on three levels: total porosity, aeration porosity (macropores), and water-holding porosity (micropores). The study found that "as a conclusion, pumice amendments to soil increased growth of strawberry plants. This is the reason of increasing level of micropores and optimum water retention capacity in pumice amended media."

A Mexican study[4] with tomato plants growing in a sand-pumice media concluded that the addition of pumice provided for a less frequent watering schedule (in controlled greenhouse conditions) without affecting flowering and fruiting: "The use of pumice particles as an improver of moisture holding capacity of sandy substrate helps plants to make an efficient use of water in the greenhouse." The researchers also noted: "One of the interesting aspects that were observed was the presence of roots in the particles of pumice [suggesting] that plant roots may have access to the water that is inside the pores of pumice, [an] event that occurs because the water in the pores of particles of pumice is held at a tension less than 0.0024 kPa, so the water is readily available."

The *Australian Journal of Crop Science* published a study[5] that looked at adding pumice to achieve gains in soil moisture absorption and retention for maize (corn) crops. The results showed that "pumice significantly ($p > 0.05$) increased the amount of soil moisture retention compared to control. Growth characteristics of maize (vegetative growth and yield) were significantly improved with increasing amounts of pumice concentration" with the max results obtained with the 30% pumice application. Advantage: Either.

Purity. Hess horticultural mine grades are typically comprised of 98% pumice and 2% other igneous minerals which are not removed through our mining processes. Perlite can also carry a trace amount of igneous materials that do not drop out during the expansion process. Advantage: Either.

Pathogen Free. Perlite, by nature of the super-heated expansion process, is free of pathogens. Pumice grades that have been dried and processed for bagging also share that distinction. The pumice mine-grades, on the other hand, are not dried or otherwise processed beyond the initial crushing and screening process, so no heating process insures the mine-grades are sterile. But for that same reason, the most economical of the in-soil pumice grades used for large native-soil amending projects—crop fields, reclamation, landscaping, or runoff filtration and control constructs—are the mine grades. Advantage: Either, depending on use/need.

Colony Ships. Potting soils are (typically and by design) sterile. When activating the soil by introducing nutrients and beneficial soil microbes, the presence of a bunch of little foamed stones throughout the soil matrix provides the perfect scaffolding for microbial life to thrive. Advantage: Either.

Commercial Use. Perlite holds the awareness advantage in horticultural and soilless grow media circles. But pumice is increasingly found in the marketplace, typically in blended potting soils from Sungro, Miracle Gro, and others. As for appearance, the stark whiteness of perlite imparts a distinct specked look to a potting soil, whereas pumice blends more unobtrusively into the media. Advantage: Either.

Grade Options. Perlite grades are determined largely in the pre-expansion process—the perlite ore is crushed and screened before expansion to roughly set the final expanded grade. Perlite is simply too light and fragile to screen extensively and effectively post-expansion. The tougher character and predictable friability of pumice allows for a wide variety of grade and grade blends—ideal for the soil engineer looking to fine-tune the water-retention to drainage-rate balance for a particular application. Advantage: Pumice.

In-Compost Advantages. While perlite and pumice are regularly combined with various compost-types in potting and garden soil recipes, studies have shown that pumice, in particular, provides advantages *during* the composting process as well, reducing VOCs, mitigating nitrogen loss, and serving as a bulking agent[6]. Advantage: Pumice.

Nothing New. As stated earlier, perlite holds the inorganic amendment awareness title in the U.S. and Canada, but the pumice-in-soil dynamic has long been leveraged in parts of the world where pumice is commonly found.

For example, the Turkish study[3] using pumice to amend soil for strawberries was not looking to determine if pumice would work, but rather at what pumice grades and amendment percentages could optimal growth be realized. A paragraph from the study's introduction: "Pumice has been used to a large extent as a plant growing media and it lightens the soil, makes tillage easier, improves soil aeration and holds water. Pumice mixed with soil in specific amounts improves soil's air and water conductivity, and reduces negative effects of crusting, cracking, flooding, and shrink-swelling. It can also be used for a long periods because of its stable physical and chemical properties and it can be provided easily since there are many pumice deposits distributed around the world. Pumice used only after sieving has a high water retention capacity, and very low bulk density value compared to soil."

About Our Pumice

Pumice is born in the fiery heart of a volcano, formed when pressurized, super-heated magma (molten stone) reaches the surface and is violently ejected—the moisture trapped within the magma flashes to steam. The final result: little lightweight pillows of porous glassy stone—remarkably useful in a wide variety of applications and industries.

It's important to note that pumice is often confused with other types of volcanic rock, like scoria. Pumice is not scoria. Scoria is common lava rock, typically red, red/brown, sometimes black, and is often used as a decorative landscaping as a ground cover. Scoria forms from basaltic magmas, while pumice is of rhyolitic magma origin. That difference is important. Pumice has many more vesicles—trapped bubbles—than scoria and the walls between the vesicles are very thin, resulting in pumice's lighter and more friable form factor. Scoria is not a drop-in subsitute for pumice.

Pumice is abundant and found in many parts of the world, but not all pumice is created equal. The pumice provided to market by Hess Pumice Products is recognized as the purest commercial deposit of white pumice in the world. The deposit is located in southeast Idaho, USA, on the shoreline of an ancient lake known as Lake Bonneville, a vast, freshwater lake that once covered much of North America's Great Basin region (most of Utah and parts of Idaho and Nevada). Today, the Great Salt Lake is all that remains of Lake Bonneville. The volcano that produced the pumice is about a mile to the north of the mine. The clouds of volcanic ash (pumice) fell into the lake, where it was washed and deeply stratified over centuries. This relentless wave washing process cleaned the pumice of the undesirable heavy minerals that are often found in other pumice deposits.

Since 1958, the responsibilty of mining and managing this unique pumice deposit has been the legacy of the Hess family. They've worked steadily to develop grade variety, blending processes, and efficiencies that have allowed them to expand the awareness and functional usefulness of pumice in a widening variety of industries, including horticulture, landscaping, and others using specialized, engineered soils. ■

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