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PRINTED: 08/29/2001

ARIZONA DEPARTMENT OF MINES AND MINERAL RESOURCES AZMILS DATA

PRIMARY NAME: HAVILAND PERLITE CLAIMS

ALTERNATE NAMES:
CRAIG CLAIMS
PERLITE

MOHAVE COUNTY MILS NUMBER: 313A

LOCATION: TOWNSHIP 16.5N RANGE 18 W SECTION 20 QUARTER --
LATITUDE: N 34DEG 48MIN 08SEC LONGITUDE: W 114DEG 09MIN 57SEC
TOPO MAP NAME: YUCCA - 7.5 MIN

CURRENT STATUS: PAST PRODUCER

COMMODITY:
PERLITE

BIBLIOGRAPHY:
ADMMR HAVILAND PERLITE CLAIMS
ADMMR HOUSEHOLDER MAPS
OCCURRENCES EXTEND INTO T17N R18W SEC 26, 28,
34

08/08/88

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OCCURRENCES EXTEND INTO T17N R18W SEC 26, 28, 34

Name of Mine or Prospect:	Towns	Range	Section	Priority
Perlite Group	16 1/2N	18w	20	B
Principal Minerals:	1:250,000 Quad		7.5' - 15' Quad	
Perlite	Needles		Yucca	
Associated Minerals:	District		Principal Product	
			Perlite (Aggregate	
Type of Operation:	County	State	Type of Deposit	
Surface: Prospects	Mohave	Ar.		

Ownership or Controlling Interest:
Consult current USBLM mining claim records

Access: From the Gem Acre Interchange on I-40, 29 miles south of Kingman, Ar., proceed west on unimproved road .5 miles. Prospects are shown (unnamed) on the topographic quadrangle.

Structural Control or Geological Association:

"Tertiary Age; rhyolite, tuff and agglomerate."[2]
"More specifically assigned Miocene Age."[3]

Age of Mineralization:

Production History	Geochemical Analyses

References

1) CETA map file Rack #5, claim map.
2) Wilson & Moore (1959) Geologic map.
3) Liggett & Childs (1974) 28 p.

HAVILAND PERLITE CLAIMS MOHAVE

Mel Jones regarding perlite deposit SW of Yucca. Duval estimated 69,000,000 tons and 53,000,000 tons inferred. Called Ben Messer in Tucson who said figures were confused and that 69,000,000 was inferred. Said he would send Mrs. Craig of Kingman the figures. FTJ WR 7/15/74

KAP WR 9/29/80: Joe Allen of Camp Verde called to report he is looking for information on a market for perlite from claims he is handling in Mohave County. (It might be Pearl Craig's perlite property near Yucca. ?)

NJN WR 11/2/84: Pearl Craig (c) visited and reported she still maintains her July Claims (Haviland Perlite Claims) Mohave County and currently has the property leased out.

HOWARD S. GABLE
BOX NO. 946
KANSAS CITY, MISSOURI 64141

July 8 1980

Mr. Melvin H. Jones,
Geologist,
Box 406,
Wickenburg,
Arizona 85358.

Dear Mel,

Some time back I acquired a copy of a report:

REPORT ON THE HAVILAND PERLITE PROPERTY

near

YUCCA, MOHAVE COUNTY, ARIZONA

by

DONN M. CLIPPINGER

DUVAL CORPORATION, April 15 1965

And in a very round-about-way some maps that had been prepared by Duval that set forth their findings. The latest map showed an indicated reserve of 186,000,000 tons.

If one were to make rough calculations on the assumption of so many hundred feet of thickness - as I have seen on a so called geological report on the Superior Arizona deposit, you could blow it up to a billion tons or what would you like??!!

At any rate I think that this report is interesting, done by some one who is high class, and further some interest is developing in perlite these days.

Looking forward to seeing you in Wickenburg soon.

Best personal regards.

Sincerely yours,

HSG/M

Enclosure.

CIRCULAR No. 12 October, 1945

Arizona Bureau of Mines - - - University of Arizona

ARIZONA PERLITE

BY

ELDRED D. WILSON* AND GEORGE H. ROSEVEARE**

INTRODUCTION

Perlite is a ciliceous volcanic glass containing between 2 and 5 per cent of water. When heated to proper temperature it "pops" or suddenly expands into light-weight, cellular glass fragments.

During recent years the possibilities for utilizing expanded perlite have attracted considerable attention. It has been produced experimentally, and to a limited extent commercially, in Arizona, California, Nevada, and other western states. Material processed in a small plant at Phoenix during 1943-44 was employed in Arizona (1) mainly for bulk insulation, light-weight insulating and acustical plaster, light-weight concrete for heat insulation, poultry litter, and as an absorbent for fertilizer. Numerous other uses for the material have been suggested or experimentally indicated in the fields of abrasives, absorbents, filters, fillers, and moulding or foundry sands for light metals.

The potential uses for perlite depend primarily upon its physical and chemical properties. These fundamental data, as we know them, have not yet been completely or adequately determined. Apparently they vary somewhat according to local geology of the deposits.

Since perlite is a volcanic glass, a study of perlite involves consideration of its distinguishing features and origin as compared with other volcanic glasses.

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* Geologist, Arizona Bureau of Mines, Tucson, Arizona

** Metallurgist, Arizona Bureau of Mines

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(1) References are listed at end of article.

General Features of the Volcanic Glasses

Species: The principal volcanic glasses are obsidian, perlite, pitchstone, vitrophyre, tachylite, pumice, and vitric or glassy tuff. They were originally defined according to their most obvious or external physical properties, but positive distinction between obsidian, perlite, and pitchstone is based upon the amount of combined water present. Accordingly, the content of water that can be driven off above 110 degrees Centigrade (expressed in analyses as plus H_2O) is less than one percent in obsidian, about 2 to 5 per cent in perlite, and 5 to 10 per cent in pitchstone. Some published analyses of obsidian, perlite, and pitchstone are as follows:

	Obsidian (a)	Perlite: rhyolitic (b)	Perlite: dacitic (c)	Perlite: andesitic (d)	Pitchstone (e)
SiO_2	73.84	74.73	69.56	65.13	70.19
Al_2O_3	13.00	10.82	15.65	15.73	12.37
Fe_2O_3	1.82	2.46	1.24	2.24	1.45
FeO	0.79	0.58	0.91	1.86	0.81
NiO				Tr.	
MgO	0.49	0.20	0.82	1.42	0.91
CaO	1.52	0.80	2.52	3.62	1.43
Na_2O	3.82	2.68	4.09	2.93	3.03
K_2O	3.92	4.40	2.19	3.96	3.57
H_2O+	0.53	2.94	2.92	2.43	6.48
H_2O-		0.27			
TiO_2	0.14	0.12		0.58	0.07
P_2O_5	0.01	0.12	0.13	0.23	0.03
MnO	0.07	0.03		Tr.	0.02
FeS_2	0.02				

(a) - Average of 41 analyses cited by Johannsen. (2)

(b) - Rhyolitic perlite, New Zealand, cited by H. S. Washington. (3)

(c) - Dacitic perlite, Columbia, cited by H. S. Washington. (3)

(d) - Andesitic perlite, Eureka, Nevada, cited by Hague. (4)
Description indicates it to be a vitrophyre, which probably accounts for the low water content.

(e) - Average of 18 analyses cited by Johannsen. (2)

Obsidian: Composition may be representative of any igneous rock type but commonly is siliceous. Combined water content is generally less than one per cent. Color black, less commonly reddish or brown and banded. Luster bright glassy. Hardness 5.5 to 7, generally 6 to 7. Gravity 2.25 to 2.7, depending on composition, but commonly 2.3 to 2.4. Fracture conchoidal to flaky with sharp edges. Thin edges transparent or translucent. Microscopically isotropic and colorless but containing numerous small inclusions. Index of refraction (5) ranges from 1.48 to 1.5. and averages 1.492. May contain spherulites (round aggregates of radiating crystals, chiefly quartz and feldspar) and lithophysae or "stone bubbles" (hollow, concentric spherulites).

Perlite: Composition most commonly rhyolitic, may range to andesitic. Characterized by about 2 to 5 per cent, generally 3 or 4 per cent, of combined water.* Color generally gray to grayish black, less commonly some shade of red, brown, green or blue. Luster pearly. Hardness 5.5 to 7. Gravity 2.23 to 2.40. Brittle. Thin edges transparent. Microscopically isotropic and colorless but may show numerous small inclusions. Index of refraction (5) ranges from 1.483 to 1.506 and averages 1.497.

Perlite tends to be intensely fractured by shrinkage cracks formed during solidification of the glass. Trypically, these partings are curved or spheroidal, forming rudely concentric shelly or unionlike textures which suggested the early name "pearlstone" or "pearlite," for the rock. (2,4) In some areas, however, the fractures are less curved, as evidenced by a predominance of columnar, splintery, bladed, or granular textures.

Shelly perlitic masses may contain subangular to spherical cores of glass (merekanite) from a fraction of an inch to more than an inch in diameter.

Spherulites, lithophysae, and cellular cavities lined with tridymite are common in perlite deposits.

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*Kozu (6) described perlite containing 5.52 to 6.55 per cent of plus H_2O.

Pitchstone: Quantitatively similar in composition to obsidian but contains 5 to 10 per cent of water. Color black, brown, green, or red. Luster pitchy rather than glassy. Hardness 5.5 to slightly above 7. Similar to obsidian in gravity and fracture. Thin edges translucent to transparent. Microscopically isotropic. Inclusions even more common than in obsidian. Index of refraction (5) ranges from 1.492 to 1.506 and averages 1.500.

Vitrophyre: Glassy volcanic rock containing abundant phenocrysts, generally of feldspar of quartz and less commonly of ferromagnesian minerals. The glass may be obsidian or pitchstone and more rarely perlite.

Tachylite: Basaltic volcanic glass. Found rarely and in relatively small amounts.

Pumice: Volcanic glass froth, most commonly of acid composition. Fibrous and highly cellular; will float on water.

Vitric or glassly tuff: Volcanic tuff composed essentially of glass fragments rather than of crystalline or stony material.

Occurrence and Origin of Volcanic Glass

The character of natural glass, whether obsidian, perlite, pitchstone, vitrophyre, pumice, or tuff, depends upon the composition of its parent magma, type of eruption, and conditions of solidification. These factors are expressed to a variable degree in the geologic field relations of the deposits.

The most favorable environment for natural glass is a thick volcanic series, prevailingly of acid to intermediate composition, that contains abundant breccia and tuff indicative of catastrophic eruption. With geologic antiquity, glass tends to devitrify or become crystalline. Thus there are few, if any known natural glasses older than Mesozoic.

Glass tends to form from a magam of acid or intermediate, rather than basic, composition. Basaltic magma is more fluid than granitic magma. Hence, basaltic eruptives crystallize readily and do not form glass except when quickly chilled.

As summarized by G. W. Morey, (7) a granitic magma remains fluid only because certain constitutents, particularly water, serve to lower the viscosity. This water, far above its critical temperature, exerts great pressure on the overlying crust. Sudden failure of the crust results in violent eruption of breccia, tuff, and magma which, losing some of its combined water and cooling rapidly, has too great a viscosity for crystallization. During quieter eruptions, the magma maintains its fluidity sufficiently long to crystallize.

Obsidian, perlite, pitchstone, and vitrophyre form masses ranging up to more than 100 feet thick and several square miles in area. Pumice occurs as flows and ejectments. Tuff occurs as beds, with or without notable stratification.

All natural glasses are generally regarded as extrusive; Grout states (8) that they occur chiefly as flows and thin selvages of dikes. However, an extrusive character for perlite and pitchstone seems questionable. It is very difficult to explain how glass such as perlite, containing sufficient water or gas to make it expand or explode when heated, could solidify under atmospheric pressure without expanding into pumice or exploding into tuff. Even if the water or gas is assumed to be presend as components that unite upon heating, what would keep them from escaping? As suggested by B. S. Butler, the water might be retained if the molten glass were intruded as near-surface sills, sheets, or dikes, which would permit rapid cooling under pressure. Perlite in some localities is demonstratly of intrusive character, but conclusive field evidence has not been obtained in enough districts or places to warrant a generalization. Further laboratory and field research is needed to throw light on this problem.

ARIZONA DEPOSITS

The best-known deposits of perlite in Arizona are near Superior, Pinal County, and in the Black Mountains of Mohave County. Other deposits are reported to occur north of Winkelman, Gila County, in the Chocolate Mountains of Yuma County, and in western Maricopa County.

Since about 1941 numerous perlite claims have been located, and small tonnages of the rock mined, particularly from the Superior and Black Mountains areas. This material was shipped to various places, chiefly Phoenix and Los Angeles, for experimental and limited commercial purposes. Recently, in anticipation of post-war demands, further development of some of the deposits has been undertaken.

Superior (Pinal County) Deposits

Extensive deposits of perlite crop out at many places within a northwestward-trending area, approximately 10 miles long by $2\frac{1}{2}$ miles wide, west of the Superior metal-mining (9) district. These deposits are 3 to 7 miles from Superior, which is served by the Magma Arizona railway, U. S. Highway 60, and the Ray Highway.

The perlite area comprises part of a basin whose surface, dissected by gulches and steep-sided canyons trivutary to Queen Creek, ranges in altitude from 2,370 to 4,370 feet on Picket Post Mountain. Its general topography is shown on U. S. Geological Survey Florence quadrangle sheet.

Here perlite occurs within a volcanic series, presumable of Tortiary age, that overlies pre-Cambrian schist on the west and dips beneath congolerate or alluvium on the east. This volcanic series attains in Picket Post Mountain a maximum exposed thickness of 1.970 feet, estimated from the schist upward as follows: (1) Tuff and breccia with locally a thin basalt flow near the base, 400 feet thick; (2) perlite, 5-45 feet; (3) rhyolite, 40-85 feet; (4) ruff and breccia, 770 feet, (5) dacite with vitrophyre at the base, to top of mountain, 670 feet.

The volcanic series as a whole lies essentially flat except for local dips of 10° - 25°. It is seen to be cut by several steeply dipping faults of north and northwestward trends which have affected displacements of generally less than 60 feet.

As a rule the perlite of the Superior area overlies tuff or breccia and underlies glassy rhyolite. Individual outcrops of the perlite range up to a few hundred feet in width but vary greatly in area according to conditions of structure, erosion, and alluvial cover. In Arnett and Telegraph canyons the perlite ranges from 40 to 100 or more feet in thickness. Apparently it thins westward and northward and is generally less than 50 feet thick in Potts Canyon.

The perlite of the Superior area south of Queen Creek shows locally more or less mareknanite (dark glass buttons) cores which contain less than one per cent of combined water and have the general properties of obsidian.

Black Mountains (Mohave County) Deposits

Large deposits of perlite have been found in the southern and middle portions of the Black Mountains, of Western Mohave County. Another deposit is reported to occur in the northwestern portion of this range, near Eldorado Canyon.

Separated from the Muddy Mountains of Nevada by Boulder Canyon, the Black Mountains extend southward for 100 miles to Sacramento Wash. The southern end of the range is skirted by the Santa Fe railway and is also accessible from the Yucca-Topock road. U. S. Highway 66 crosses the southern portion of the range through the Oatman gold district, and the Kingman-Bullshead highway leads through the Union Pass and Katherine gold districts, 12 miles farther north. The middle portion of the range is accessible from the Boulder dam highway by roads that lead to the Producers mine.

The topography of the southern end of the range is shown on U. S. Geological Survey Yucca and Needles sheets. An outline of the general geology of the Black Mountains and detailed descriptions of the Oatman and Katherine districts have been published. (10)

The Black Mountains rise in altitude from 1,100 feet at their southern base to 5,500 on their highest northern peaks. Much of their surface is steep and very rugged. The southern and middle portions of the range consist largely of Tertiary volcanic rocks which in places are seen resting upon granite, gneiss, and schist. This volcanic series, totalling 8,000 to 10,000 feet in thickness (10) consists largely of trachyte, andesite, latite, tuff, and basalt. Intrusive into parts of this series are porphyries of granitic to monozonitic composition. The volcanic series as a whole dips gently eastward and is cut by numerous faults of prevailingly northwestward strike. (10)

The perlite, 25 to more than 100 feet thick, occurs in the upper portion of this volcanic series. It forms exposures several hundred square feet in area at many places and extends for undetermined distances beneath breccia, tuff, latite, and basalt.

Southern area: In the southernmost portion of the Black Mountains perlite crops out in secs. 22, 26, 27, 28, 34, and 35, T. 17N., R. 18 W. These deposits, north of Haviland and southwest of Yucca, are within 3/4 to 2 miles of the Santa Fe railway.

In the northern portion of sec. 27, the following succession extends upward from the valley fill (thicknesses estimated): (1), tuff and breccia containing angular boulders of perlite up to more than 6 feet in diameter, 400 feet thick; (2) perlite, 90 to 150 feet; latitie breccia, 35 to 50 feet; (3) latite, 50 feet; pumiceous glass and tuff, 90 feet; (4), latite, capped by basalt northward, 60 feet.

The perlite of this area contains phenocrysts of quartz ranging up to about 0.1 inch in diameter.

Southward the volcanic series dips gently southeastward and is displaced somewhat by faults of northwest strike. On the west bank of Sacramento Wash., in sec. 35, the breccia-perlite lower contact dips beneath the surface. Here the perlite crops out mainly as an oblong area about 100 feet long by a maximum of 75 feet wide. It forms a mass approximately 150 feet in thickness of which the lowest 50 feet is relatively pure perlite showing some quartz phenocrysts; its middle 50 feet contains several layers of spherulitic rhyolite; and the upper 50 feet consists of alternating bands of perlite and latite. Intrusive latite forming the crest of the ridge is in contact with this perlite mass on the west.

Middle area: Perlite occurs in the eastern middle portion of the Black Mountains, particularly in T. 22 and 23 N., R. 19 and 20 W. It crops out intermittently along the ridges that extend east of the pipeline road, for 3 miles south of the producers mine.

The volcanic series containing perlite is well exposed in an eastward-tilted fault-block ridge one mile southwest of the Producers mine. Here the following section from west to east was measured: (1), latite, 150 feet exposed; (2), dark-gray tuff and mudstone, 35 feet; (3), dark-gray glass with granular fracture, 10 feet; (4), brown cellular latite, 40 feet; (5), talus covered, 150 feet, with 8 feet of coarse tuff exposed; (6), fine-grained tuff, 80 feet; (7), tuff and breccia with fragments of perlite up to more than a foot in diameter, 15 feet; (8), perlite, 12 feet; (9), alternating bands of perlite and tuff, 25 feet; (10), tuff and breccia of perlite fragments, 30 feet; (11), fine-grained tuff, 30 feet; (12), cellular basalt flow, 8 feet; (13), fine-grained tuff and breccia of perlite fragments, 30 feet; (14), black perlite, 3 to 30 feet; (15), platy rhyolite, 75 feet.

East of the windmills in sec. 2, T. 22 N., R. 20 W., a mass of perlite approximately 50 feet thick and dipping 30° west overlies thick volcanic breccia and underlies tuff. This outcrop extends southward for approximately 1/4 mile. Its upper 25 feet contains bands of latite.

QUALITY FEATURES OF PERLITE

In order to determine how raw perlite of good expanding quality may be distinguished from that of poor quality, numerous samples from Arizona and a few from outside the State were tested. Although it is admitted that additional, undetermined physical and chemical properties may have important bearing on this matter, the following generalizations seem to be warranted:

Physical and Chemical Properties	Expansion qualities good	Expansion qualities poor
Luster	Shiny or pearly	Dull
Fracture	Perlitic, columnar, or splintary; shatters into sharp, angular fragments	Tendency to non-perlitic and platy; shatters into granulat or powdery fragments.
Marekanites (dark glass buttons)	Presence is favorable indication, but not essential.	Absent.
Specific gravity	Predominatly 2.33-2.40	Predominatly 2.31-2.36
Combined water (plus H_2O)	Predominatly 3.0-4.2 per cent	2.42-4.95 per cent
Alkalinity (ph)	7.4-8.6 (apparently not distinctive).	7.4-8.6 (apparently not distinctive).
Index of refraction	Apparently not distinctive.	Apparently not distinctive.
Microscopic inclusions	Clear crystallites, bubbles, and very fine dark particles.	Little or no crystallites and bubbles; may or may not contain very fine dark particles.
Phenocrysts	Minimum or phenocrysts, such as quartz, feldspar, and biotite.	Abundant phenocrysts.

WORKS TO WHICH REFERENCE IS MADE

1. Ariz. Bureau of Mines Bull.152, p. 35 (1944).

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Perlite Institute

45 WEST 45th ST., NEW YORK 36, N. Y.

No. 1-1 1962

ORIGIN AND CHARACTERISTICS

TYPICAL CHEMICAL AND PHYSICAL PROPERTIES OF PERLITE

Perlite is not a trade name but a petrographic term for a naturally occurring siliceous volcanic rock. The distinguishing feature which sets perlite apart from other volcanic glasses is that when heated to a suitable point in its softening range, it expands four to twenty times its original volume.

This expansion is due to the presence of two to six per cent combined water in the crude perlite rock. When heated above 1600 degrees F, the crude rock pops in a manner similar to popcorn as the combined water vaporizes and creates countless tiny bubbles in the heat softened glassy particles. It is these tiny glass-sealed bubbles which account for the amazing light weight and other exceptional physical properties of expanded perlite.

The expansion process also creates one of perlite's most distinguishing characteristics: its white color. While the crude rock may range from transparent light gray to glossy black, the color of expanded perlite ranges from snowy white to grayish white.

Expanded perlite can be manufactured to weigh as little as 2 lbs. per cu. ft. making it adaptable for numerous industrial uses. Crude perlite is found in the Western United States. Perlite processing plants are conveniently located to serve all sections of the country.

This technical data sheet presents typical properties which are broadly applicable to all expanded perlite.

TYPICAL CHEMICAL ANALYSES

Silicon dioxide	(SiO_2)	71.0 to 75.0%
Aluminum oxide	(Al_2O_3)	12.5 to 18.0%
Potassium oxide	(K_2O)	4.0 to 5.0%
Sodium oxide	(Na_2O)	2.9 to 4.0%
Calcium oxide	(CaO)	0.5 to 2.0%
Ferric oxide	(Fe_2O_3)	0.5 to 1.5%
Magnesium oxide	(MgO)	0.1 to 0.5%
Titanium dioxide	(TiO_2)	0.03 to 0.2%
Manganese dioxide	(MnO_2)	0.03 to 0.1%
Sulfur trioxide	(SO_3)	0 to 0.2%
Ferrous oxide	(FeO)	0 to 0.1%
Chromium	(Cr)	0 to 0.1%
Barium	(Ba)	0 to 0.05%
Lead oxide	(PbO)	0 to 0.03%
Nickel oxide	(NiO)	Trace
Copper	(Cu)	Trace
Boron	(B)	Trace
Beryllium	(Be)	Trace
Molybdenum	(Mo)	Trace
Arsenic	(As_2O_3)	Less than 0.1 ppm
Free Silica		0 to 2%
Total chlorides		Trace to 0.2%
Total sulphates		None

TYPICAL CHEMICAL AND PHYSICAL PROPERTIES

	Crude	Expanded
	% By Weight	% By Weight
Ignition Loss - 1800° F.	2.8%	
SiO_2	73.0%	75.33%
Al_2O_3	13.3%	13.72%
Fe_2O_3	0.67%	0.69%
P_2O_5	Trace	Trace
TiO_2	0.14%	0.14%
CaO	0.82%	0.85%
MgO	0.09%	0.09%
Na_2O	4.04%	4.17%
K_2O	4.81%	4.96%
Sulfates	None	None
Surface Moisture	0.3%	0.0 - 0.7%
pH	7.6%	7.7%
Solubles - Water		0.08%
Solubles - Hot 1:3 HCl	1.4%	1.6%

APPLICATIONS FOR "SEVEN HILLS OF TAOS" PERLITE

BUILDING:
Accoustical Tile - Rigid Insulation Board for Roof Deck
Acoustical Plaster
Lightweight Concrete Roof Decks - Curtain Wall Backup
Plaster Aggregate - Fireproofing
Pre-cast Concrete Slabs - Floor Fill - Masonry Fill
Lightweight Concrete Blocks - Ceramic Tile Grout

HORTICULTURAL:
Permanent Soil Conditioner - Plant Reproduction
Plant Packaging - Bulb and Tuber Storage
Insecticide Carrier - Fertilizer Bulking
Seed Bed Preparation

INDUSTRIAL:
Filler in Plastics, Paints, Rubber, Soap and Other Chemical Products
Insulating Cements
Refractory Materials
Insulation - Cryogenic
Fireproofing Storage Tanks
Foundry Risers and Ladle Covers
Polishing Abrasives
Paint Texturing Aggregate

While crude perlite is found only in Western United States, perlite processing plants are conveniently located to serve all sections of the country.

closed cellular structure . . .

The glassy, closed cellular structure of individual particles of perlite aggregate sets it apart from other aggregates in the same weight class.

The myriad cells or bubbles sealed inside perlite particles resist penetration by water. However, fractured bubbles at the surface of the perlite particle greatly increase the total surface area so that perlite tends to *absorb* water on the surface rather than trapping it within the particle.

Due to its greater surface area per cubic foot of aggregate, perlite requires more mixing water than smooth-surfaced dense aggregates, but about 30% less water than open celled aggregates in the same weight class.

This surface-held water is given off rapidly in drying. Consequently, because of their comparatively low water requirements, perlite plasters and concretes develop greater strength and dry out much more rapidly than other aggregates of similar light density.

insulating properties . . .

As thermally insulating, expanded perlite gives excellent results at temperatures ranging from very low to very high. For example, perlite is one of the best known insulations for the manufacture and storage of liquid gases such as [illegible] temperatures as low as -400° F.

[illegible] is effective as a ladle [illegible] to prevent surface cool[illegible] during pouring. At high temperatures, expanded perlite begins to soften at about 1800° F., while fusion of the particles on the exposed surface begins at about [illegible]

[illegible] an excellent fill for insulating [illegible] walls. Tests have shown that granular perlite poured into the cores of [illegible] hollow concrete [illegible] can [illegible] transmission by 50%.

Thermal Conductivity
LOOSE FILL EXPANDED PERLITE
AT VARIOUS DENSITIES

[illegible] AROUND [illegible] TEMPERATURES

[illegible] graphs based on tests from [illegible] Research Foundation and [illegible]

TYPICAL PHYSICAL PROPERTIES

Color	White
Softening point	1600° - 2000° F
Fusion point	2300° - 2450° F
pH	6.6 to 8.0
Specific heat	0.20
Specific gravity	2.2 to 2.4
Refractive index	1.5
% Free moisture, maximum	0.5
Loose weight, pcf	As desired
Solubility	—Soluble in hot concentrated alkali and in hydrofluoric acid. —Slightly soluble (< 2%) in concentrated mineral acids. —Very slightly soluble (< 0.1%) in dilute mineral or concentrated weak acids.

PRODUCED BY Perlite Institute, Inc. 45 WEST 45th ST., NEW YORK 36, N. Y.

origin and characteristics . . .

Typical deposit of crude perlite has soil overburden stripped away ready for quarrying.

"Perlite" is not a trade name. It is a petrographic term for a naturally occurring siliceous rock defined by Webster's Dictionary as "volcanic glass with a concentric shelly structure." However, the distinguishing feature which sets perlite apart from other volcanic glasses is the fact that when heated to a suitable point in its softening range it expands 4 to 20 times its original volume.

This expansion is due to the presence of two to six per cent combined water which occurs in the crude perlite rock. When heated above 1600 degrees F the crude rock pops in a manner similar to popcorn as the combined water vaporizes and creates countless tiny bubbles in the heat-softened glassy particles. It is these tiny glass-sealed bubbles which account for the amazingly light weight and excellent thermal insulation of expanded perlite.

At the same time, the expansion process creates one of perlite's most important distinguishing characteristics: *its white color.* While the crude rock may range from transparent light gray to glossy black, the color of expanded perlite ranges from snowy white to grayish white.

Expanded perlite can be manufactured to weigh as little as 2 to 4 pounds per cubic foot. Such light weights are well adapted for some types of loose fill insulation and for numerous industrial uses. However, perlite aggregates for plaster and concrete have a density range of 7½ to 15 pounds per cubic foot in compliance with A.S.T.M. specifications.

The size gradation of expanded perlite aggregate for normal use in plaster and insulating concrete is also specified by the American Society for Testing and Materials. Current specifications for plaster aggregate and concrete aggregate are as follows:

U. S. Standard Sieve No.	ASTM C-35 Plaster Aggregate (% retained by volume)		ASTM C-332 Concrete Aggregate (% retained by weight)	
	Maximum	Minimum	Maximum	Minimum
8	5	0	15	0
16	60	5	60	15
30	95	45	80	40
50	98	75	95	75
100	100	88	100	90

Since perlite is a form of natural glass, it is classed as chemically inert and has a pH of approximately 7. Sterile and free of organic impurities, perlite has no accelerating effect on the setting time of gypsum or portland cement binders.

Crude perlite Crushed crude perlite Expanded perlite

THREE STAGES OF PERLITE PROCESSING shown above illustrate the great increase in volume after furnacing. The same weight of perlite (one ounce) is shown in each photo.

TYPICAL RANGE SIEVE ANALYSIS FOR SEVEN HILLS PERLITE ORE

Grade No.		PA-110	PA-120	PA-130
U.S. Sieve	+ 30	0- 1%	5-10%	0- 5%
	- 30 + 50	3- 9%	34-44%	57-67%
	- 50 +100	30-40%	25-35%	28-38%
	-100	50-65%	20-30%	0- 3%

Grade No.		PA-2	PA-210	PA-220
U.S. Sieve	+ 20	4- 7%	8-12%	9-14%
	- 20 + 30	13-18%	24-29%	27-35%
	- 30 + 50	52-62%	45-55%	40-50%
	- 50 +100	17-26%	12-17%	7-12%
	-100	0- 2%	0- 2%	0- 2%

Grade No.		PA-3	PA-310	PA-320
U.S. Sieve	+ 16	2- 5%	4- 7%	8-12%
	- 16 + 20	13-18%	14-20%	17-24%
	- 20 + 30	30-40%	28-36%	28-38%
	- 30 + 50	35-45%	36-46%	29-37%
	- 50 +100	2- 5%	4- 8%	2- 5%
	-100	0- 2%	0- 2%	0- 2%

Grade No.		PA-4	PA-420	PA-430
U.S. Sieve	+ 8	0	0- 1%	+ 12 0- 2%
	- 8 + 16	13-17%	20-25%	- 12 + 16 25-40%
	- 16 + 30	50-60%	54-64%	- 16 + 20 40-55%
	- 30 + 50	24-28%	10-20%	- 20 + 30 10-20%
	- 50	0- 4%	0- 3%	- 30 0- 5%

Grade No.		PA-6	PA-610
U.S. Sieve	+ 8	0- 5%	0- 6%
	- 8 + 12	26-42%	30-50%
	- 12 + 16	37-52%	40-60%
	- 16 + 20	11-17%	4-10%
	- 20	0- 6%	0- 6%

Information on Special Gradations available on request.

SHIPPING

Seven Hills Ore is shipped in bulk in railroad boxcars or hopper cars. Minimum loading is 40 or 50 tons, depending on freight tariffs to destination. Extra-large 3 compartment cars holding 70 tons are usually available on request. Shipping point is Antonito, Colorado. Across-the-car bulkheading, leaving approximately 9 feet of clear space at doorways, will be installed on request, at cost, for shipments containing two separate grades in one car.

PRICES - SAMPLES

Ore prices, and information on test lots are available on request. Direct queries to: Johns-Manville Perlite Corporation, P. O. Box 1145, Joliet, Illinois.

TYPICAL USES OF "SEVEN HILLS OF TAOS" PERLITE

Use:	Grade Recommended	Typical Sieve Analysis After Expansion
INSULATION-CRYOGENIC	PA 110	% By Weight
		+ 16 — 1.2%
		+ 20 — 3.8%
		+ 30 — 17.5%
		+ 50 — 49.0%
		+ 100 — 77.7%
		- 100 — 22.3%
		TYPICAL DENSITY: Loose - 2.3 lb /cu. ft. Compacted - 3.2 lb./cu.ft.
Fine Plaster (ASTM C35-62)	PA 210	% By Volume
		+ 8 — Trace
		+ 16 — 13.5%
		+ 30 — 63.8%
		+ 50 — 85.6%
		+ 100 — 93.5%
		- 100 — 6.5%
Medium Plaster (ASTM C35-62)	PA 3	% By Volume
		+ 8 — 0.2%
		+ 16 — 22.3%
		+ 30 — 77.9%
		+ 50 — 87.7%
		+ 100 — 92.3%
		- 100 — 7.7%
Fine Concrete (ASTM C332-61)	PA 3	% By Weight
		+ 8 — 2.0%
		+ 16 — 32.1%
		+ 30 — 78.9%
		+ 50 — 89.6%
		+ 100 — 94.6%
		- 100 — 5.4%
Coarse Concrete (ASTM C332-61)	PA 4	% By Weight
		+ 8 — 5.9%
		+ 16 — 52.9%
		+ 30 — 73.2%
		+ 50 — 87.7%
		+ 100 — 93.5%
		- 100 — 6.5%
Horticulture (Ideal for screening to meet PERL-LOME Specification)	PA 6	% By Volume
		+ 8 — 57.3%
		+ 20 — 86.8%
		+ 30 — 89.7%
		+ 50 — 93.1%
		- 50 — 6.9%

DEPARTMENT OF MINERAL RESOURCES

STATE OF ARIZONA
Phoenix, Arizona

Chas. H. Dunning, Director

PERLITE

Compiled for the Department
by
Earl F. Hastings, Mining Engineer
of
Darlington, Hastings & Thorne
Industrial Consultants
Phoenix, Arizona

1947

P E R L I T E

PRODUCTION AND USE

INTRODUCTION:

The volume of inquiries reaching this department has made necessary a report on the relatively new material, perlite.

This report is not intended as a technical treatise on the production or uses of perlite, but is rather a collection of facts and opinions, often without correlation, by which those interested might find answers, in part, to inquiries on the subject.

ACKNOWLEDGMENTS:

In the course of obtaining authentic material for the preparation of this report, every known producer of perlite or fabricator of perlite products, whether within the State or without, was invited to submit pertinent data.

Apologies are offered those who may have been overlooked in locating perlite producers and fabricators, and sincere gratitude is expressed to those listed below who contributed, or offered to contribute and assemble, information for this report and for the benefit of the industry in general:

Alexite Engineering Co., Colorado Springs, Colorado
Great Lakes Carbon Co., Los Angeles, California
Murdock & Bassler, Phoenix, Arizona
National Perlite Company, Campbell, California
Rheem Research Products Co., Los Angeles, California
United States Perlite Co., Los Angeles, California
Western Perlite Corporation, Phoenix, Arizona

Free use has been made of the reports of :

U. S. Bureau of Mines, I. C. 7364
"Perlite, Source of Synthetic Pumice", Oliver C. Rolston,
August, 1946.

Arizona Bureau of Mines, "Arizona Perlite", Eldred D.
Wilson and George H. Rosevcare, October, 1945.

Arizona Bureau of Mines, Metallurgical Tests Ore
No. 712, E. H. Crabtree, Jr.

Both of the above agencies have accomplished much and are now engaged in experimentation on the production and uses of perlite. Considerable neutral and authentic information may be expected from these sources in the future.

DEFINITION:

"Perlite is a siliceous volcanic glass containing between two and five percent of water. When heated to proper temperature it 'pops' or suddenly expands into lightweight cellular glass fragments." (1)* It is closely related to obsidian and pitchstone and is found in proximity to a variety of glasses of volcanic origin.

Not being a common host rock for metallics, nor in itself having had particular merit in commercial fields, it has been only in the past few years that more than passing attention has been given perlite.

"Since perlite is a volcanic glass, a study of perlite involves consideration of its distinguishing features and origin as compared with other volcanic glasses", and is discussed by Eldred D. Wilson and George H. Roseveare as follows:

> "Species: The principal volcanic glasses are obsidian, perlite, pitchstone, vitrophyre, tachylite, pumice and vitric or glassy tuff. They were originally defined according to their most obvious or external physical properties, but positive distinction between obsidian, perlite, and pitchstone is based upon the amount of combined water present. Accordingly, the content of water that can be driven off above 110 degrees Centigrade (expressed in analyses as plus H_2O) is less than one percent in obsidian, about 2 to 5 percent in perlite, and 5 to 10 percent in pitchstone. Some published analyses of obsidian, perlite, and pitchstone are as follows:

		Perlite			
	Obsidian (a)	rhyolitic (b)	dacitic (c)	andositic (d)	Pitchstone (e)
SiO_2	73.84	74.73	69.56	65.13	70.19
Al_2O_3	13.00	10.82	15.65	15.73	12.37
Fe_2O_3	1.82	2.46	1.24	2.24	1.45

*(1) Eldred D. Wilson, Arizona Bureau of Mines.

	Obsidian (a)	rhyolitic (b)	dacitic (c)	andesitic (d)	Pitchstone (e)
FeO	0.79	0.58	0.91	1.85	0.81
NiO				Tr.	
MgO	0.49	0.20	0.82	1.42	0.91
CaO	1.52	0.80	2.52	3.62	1.43
Na_2O	3.82	2.68	4.09	2.93	3.03
K_2O	3.92	4.40	2.19	3.96	3.57
H_2O-	0.53	2.94	2.92	2.43	6.48
H_2O+		0.27			
TiO_2	0.14	0.12		0.58	0.07
P_2O_5	0.01	0.12	0.13	0.23	0.03
MnO	0.07	0.03		Tr.	0.02
FeS_2	0.02				

"(a) - Average of 41 analyses cited by Johannsen (2)
(b) - Rhyolitic perlite, New Zealand, city by H. S. Washington (3)
(c) - Dacitic perlite, Columbia, cited by H. S. Washington (3)
(d) - Andesitic perlite, Eureka, cited by Hague (4)
Description indicates it to be a vitrophyre, which probably accounts for the low water content.
(e) - Average of 18 analyses cited by Johannsen (2)

"Obsidian: Composition may be representative of any igneous rock type but commonly is siliceous. Combined water content is generally less than one percent. Color black, less commonly reddish or brown and banded. Luster bright glassy. Hardness 5.5 to 7, generally 6 to 7. Gravity 2.25 to 2.7, depending on composition, but commonly 2.3 to 2.6. Fracture conchoidal to flaky with sharp edges. Thin edges transparent or translucent. Microscopically isotropic and colorless but containing numerous small inclusions. Index of refraction (5) ranges from 1.48 to 1.51 and averages 1.492. May contain spherulites (round aggregates of radiating crystals, chiefly quartz and feldspar) and lithophysae or 'stone bubbles' (hollow, concentric spherulites).

"Perlite: Composition most commonly rhyolitic, may range to andesitic. Characterized by about 2 to 5 percent, generally 3 or 4 percent, of combined water. Color generally gray to grayish black, less commonly some shade of red, brown, green, or blue. Luster pearly. Hardness 5.5 to 7. Gravity 2.23 to 2.40. Brittle. Thin edges transparent. Microscopically isotropic and colorless but may show numerous small inclusions. Index of refraction (5) ranges from 1.483 to 1.506 and averages 1.497.

"Perlite tends to be intensely fractured by shrinkage cracks formed during solidification of the glass. Typically, these partings are curved or spheroidal, forming rudely concentric shelly or onionlike textures which suggested the early name 'pearlstone' or 'pearlite' for the rock. (2,4) In some areas however, the fractures are less curved, as evidenced by a predominance of columnar, splintery, bladed, or granular textures.

"Shelly perlitic masses may contain subangular to spherical cores of glass (marekanite) from a fraction of an inch to more than an inch in diameter.

"Spherulites, lithophysae, and cellular cavities lined with tridymite are common in perlite deposits.

"Pitchstone: Quantitatively similar in composition to obsidian but contains 5 to 10 percent of water. Color black, brown, green or red. Luster pitchy rather than glassy. Hardness 5.5 to slightly above 7. Similar to obsidian in gravity and fracture. Thin edges translucent to transparent. Microscopically isotropic. Inclusions even more common than in obsidian. Index of refraction (5) ranges from 1.492 to 1.506 and averages 1.500.

"Vitrophyre: Glassy volcanic rock containing abundant phenocrysts, generally of feldspar or quartz and less commonly of ferromagnesian minerals. The glass may be obsidian or pitchstone and more rarely perlite.

"Tachylite: Basaltic volcanic glass. Found rarely and in relatively small amounts.

"Pumice: Volcanic glass froth, most commonly of acid composition. Fibrous and highly cellular; will float on water.

"Vitric or glassy tuff: Volcanic tuff composed essentially of glass fragments rather than of crystalline or stony material.

"Occurrence and Origin of Volcanic Glass: The character of natural glass, whether obsidian, perlite, pitchstone, vitrophyre, pumice, or tuff, depends upon the composition of its present magma, type of eruption, and conditions of solidification. These factors are expressed to a variable degree in geologic field relations of the deposits.

"The most favorable environment for natural glass is a thick volcanic series, prevailingly of acid to intermediate composition, that contains abundant breccia and tuff indicative of catastrophic eruption. With geologic antiquity, glass tends to devitrify or become crystalline. Thus there are few, if any, known natural glasses older than Mesozoic.

"Glass tends to form from a magma of acid or intermediate, rather than basic composition. Basaltic magma is more fluid than granitic magma. Hence basaltic eruptives crystallize readily and do not form glass except when quickly chilled.

"As summarized by G. W. Morey (7), a granite magma remains fluid only because certain constituents, particularly water, serve to lower the viscosity. This water, far above its critical temperature, exerts great pressure on the overlying crust. Sudden failure of the crust results in violent eruption

"of breccia, tuff, and magma which, losing some of its combined water and cooling rapidly, has too great a viscosity for crystallization. During quieter eruptions, the magma maintains its fluidity sufficiently long to crystallize.

"Obsidian, perlite, pitchstone, and vitrophyre form masses ranging up to more than 100 feet thick and several square miles in area. Pumice occurs as flows and ejectments. Tuff occurs as beds, with or without notable stratification.

"All natural glasses are generally regarded as extrusive; Grout states (8) that they occur chiefly as flows and thin selvages of dikes. However, an extrusive character for perlite and pitchstone seems questionable. It is very difficult to explain how glass such as perlite, containing sufficient water or gas to make it expand or explode when heated, could solidify under atmospheric pressure without expanding into pumice or exploding into tuff. Even if the water or gas is assumed to be present as components that unite upon heating, what would keep them from escaping? As suggested by B. S. Butler, the water might be retained if the molten glass were intruded as near surface sills, sheets, or dikes, which would permit rapid cooling under pressure. Perlite in some localities is demonstrably of intrusive character, but conclusive field evidence has not been obtained in enough districts or places to warrant a generalization. Further laboratory and field research is needed to throw light on this problem."

HISTORY:

The history of the perlite industry in its present stage apparently originated with the discovery and development of the process of "popping" the raw material by L. Lee Boyer, a metallurgist, in his laboratories in Superior, Arizona.

The peculiar property of perlite in exploding when heated to a critical temperature was first reported by S. Kozu of the Tohoku Imperial University in Japan in 1929 or 1930. Kozu, in reporting expansion properties of various volcanic glasses, merely stated that perlite exploded at a certain point; he did not study the resultant product or pursue the subject further, nor would his laboratory technique be applicable to commercial production without considerable modification.

It remained for Mr. Boyer to rediscover the explosive action of

TABLE 1

District or area	Name of Mine	Periods of Production	Minerals Produced	Amount Produced	Source of Information
Oatman	Tom Reed	1909-1931	Gold & Silver	984,000 tons ore at $13,000,000	7
	United Eastern	1915-1926	Gold & Silver	697,000 tons ore at $15,000,000	7
	Gold Road	1897-1924	Gold & Silver	738,000 tons ore at $7,000,000	7
	Moss	1860's & early 1900's	Gold	$250,000	7
	Telluride	1922-1925	Gold	$200,000	7
	Unknown	1953	Brucite	A few tons	2,4
	Vivian	1938&1949	Lead	A few tons lead	7
Katherine - Union Pass	Katherine	1900-1930	Gold & Silver	$1,000,000	7
	Roadside	1915-1934	Gold & Silver	890 oz. gold 1734 oz. silver	7
	Arabian	1917-1933	Gold & Silver	593 oz. gold 1156 oz. silver	7
Northern Black Mountains	Gold Bug	1893-1932	Gold & Silver	$55,000	7
	Mocking Bird	before 1908	Gold & Silver	$20,000	7
	Pilgrim	1903-1934	Gold	unknown	7
Southern Black Mountains	Unknown	1950's or 1960's	Clay	estimated at few hundred tons	2
	Unknown	1942	Perlite	Two carloads	2,4

Note: Where possible the amount of commodity produced was listed. Dollar values for gold production are based on a price of $20/oz.

MELVIN H. JONES
Mining Geologist
~~Box 1, Mountain, Nevada 89830~~
Box 406, Wickenburg, Az. 85358.
12 July, 1974.

MEMORANDUM FOR THE RECORD.

SUBJECT: Haviland Perlite claims (owned by Mr. Howard S. Gable).

AT the request of Mr. Howard S. Gable, box 946, Kansas city, Mo., the writer made a trip to Kingman, Arizona (and then down to Yucca to the Haviland claims) on July 11, 1974.

A map had been located showing the mentioned perlite deposits when they were owned by the Duval Copper Company. Apparently this map was made by the Duval engineers. This map reveals all of the Duval claims and delineates the regions that have perlite. There is several large areas that have "pumaceous" perlite, and several much smaller regions with "perlitic" perlite. On the map is an inferred total tonnage of 53 million tons. No proven tonnage is shown. It had been understood in the past (from hearsay information) that there is 68 million tons of perlite on the claims ???

The writer, and Mr. Jack Day, then proceeded to the Haviland clidims, with the said map, and examined several areas containing the "pumaceous" perlite and compared the material found there with other areas having "perlitic" perlite. At this point, it is well to mention that the perlitic perlite is of commercial grade. It is the typical glassey type with concentric cracks.

However, the so called "pumaceous" perlite is a different story. This more closely approximates a tuff, in the opinion of the writer. The term "pumaceous" implies the presence of pumice. Pumice should be like a sponge and be highly cellular, and is the result of explosive volcanic action, and it should still be glassey. A tuff, on the other hand is a volcanic ash and it can be compacted into solid rock and it is not glassey. On the other hand, the Perlite industry calls any rock that contains 2 to 5% water, and that can be expanded by heating, a perlite. Maybe its a matter of semantics. In any event, several samples of the so called pumaceous perlite should be obtained and tested without delay as to its commercial practicability. (Unless this has already been done by Mr. Gable and/or associates?).

Mr. Day checked the County Recorder's records and learned that the so called railroad sections, (adjoining the Haviland claims) had been held by the New Mexico and Arizona Land Company in the past. But they were relinquished on January 10, 1973 by said company (and returned to the RR company ?). He also ascertained the same information from the BLM office in Kingman.

Cores, from the current drilling program (which are in storage at a commercial sharehouse in Kingman) were also looked over by the writer. Only about 2 feet of perlitic perlite was noted, but there is much of the so called pumaceous perlite.

A study into the so-called perlite reserves, should be undertaken. To do this properly, much additional drilling is required. Also the "pumaceous" perlite should be tested in a laboratory.

Septem _ 14, 1973

RECONNAISSANCE GEOLOGY INVESTIGATION OF PERLITE CLAIMS, LOCATED SEVEN (7) MILES SOUTH OF YUCCA, MOHAVE COUNTY, ARIZONA.

In accordance with instructions of Mr. Howard S. Gable, Box 946m Kansas City, Mo., a cursory and rapid geology examination was made of the seven (7) "JULY" claims containing perlite located seven(7) miles South of Yucca, Arizona, was made on September 13, 1973. The claims are owned by the United Investors company, of Kingman, Arizona. Mrs. Pearl Craig, Vice-President of said commpany, accompanied the undersigned.

I am told that the Duval Copper Company (Kingman,Az) formerly had more than fifty (50) claims covering the perlite area (assuming the perlite was all they were interested in ?), but they abandoned them. United Investors re-located seven claims in what they feel is the best perlite local. Mrs. Craig has a letter from Duval stating that they have no objections to the "July" claim re-location. I was also told that Duval drilled nine holes on the property in depths varying from 30 to 165 feet. United Investors does not have any of this drillhole data.

The claims are located alongside Highway 66 (and the Santa Fe railroad) seven (7) miles below Yucca. (see attached map). there is a railroad siding there called Haviland, and I am told that perlite has been shipped from Haviland in the past.

The perlite is in hills of silicic volcanic rocks of Tertiary age, that are part of the Black Mountains. Some of the rocks examined in the vicinity of the several perlite veins is of a welded tuff composition. Some of the veins of perlite are 100 feet(or more) in width and their lengths are unknown (but considerable), as they are obscurred by the mentioned tuffs. The depths are also unknown. There are apparently a series of these large perlite deposits (parallel to each other), but with some distance between them. There are, however, several large man made pits scattered in the area, showing 10 foot perlite exposures. It would appear that there is a large amount of perlite on the claims (from an inferred viewpoint, this would be several million tons).

The grade of this perlite is not known to the writer. This can only be determined in special laboratories where its water content, particle size, percent of devitrification, and other factors can be determined. The perlite is grey in color, grading to white in some cases.

CONCLUSIONS: Before buying, or leasing, (or undertaking development work) on this property, a market study should be made. Transportation costs are always a big factor. If a market can be found at a suitable price, then the perlite can be mined (hopefully at a profit). Prices for perlite are normally negeciated, but they can be from $10.00 a ton (and up) for crude perlite.

As an incidental matter, some alluvial sand samples that Mrs. Craig had obtained from an area North of Glendale, Az., were examined for Fe content. The magnetite (and illmanite) content was found to be under 1 %.

Box 406, wickenburg, Az. MELVIN H JONES, Mining Geologist.

Yucca
Ariz.
Needles
Calif.
Havasu
Peak
Claims
SACRAMENTO
Topography by J.L. Lewis
Surveyed in 1927
YUCCA, Az.
15 Minute Quad
SCALE 1:62500
Contour interval 25
FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER COLOR
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SY

Haviland
Perlite

Perlite Data

BLACK MOUNTAINS PLANNING UNIT 02-02

MINERALS

STEPS 3 and 4

Several minerals occur in minor amounts in the gold-quartz veins in the Black Mountains. Silver and lead production from these veins have been, and probably always will be, dependent on gold production. Vismuth, vanadium, beryllium, and fluorite also occur in the veins in small amounts. It is unlikely that these minerals will ever be produced in commercial quantities in the planning unit.

Brucite

Brucite-1 was designated on the basis of several blocks of mining claims located for brucite. Within this IMA is ~~an~~ MRA-1 that is based on the occurrence of the brucite deposits. According to several sources, (Step 3), these deposits consist of partially inventoried reserves. Although they are low-grade deposits, they should be considered a potential mineral resource. Increased demand for magnesium metal (Step 3) could result in development of these deposits in the foreseeable future. Likely mining methods could either be underground or open pit, since the deposits are sometimes nearly flat lying and other times steeply dipping.

Clay

The boundary of Clay-1 encloses an area in which several clay deposits occur. The boundary is rather arbitrary and is intended to indicate an area where clay is likely to be found; as more becomes known about clay occurrences in this area the boundary may change. MRA-3 encloses the area in E½SE¼ Sec. 35, T. 17 N., R. 19 W., where clay was mined in the past. Published information indicates that there may be substantial reserves of good quality refractory clay at this deposit. At first glance, it appears that

an attempt to mine the clay failed; however, sustained production may not have been planned from the start since the clay was used in the construction of an airport. Further production will depend on similar needs or demand for refractory material. It is believed that the clay deposits in Clay-1 have potential for further production. Any future mining will continue to be by open pit.

Perlite

The boundary of Perlite-1 was designated on the basis of the geologic occurrence of a large perlite deposit. ~~The MRA~~ MRA-4 also is located within Perlite-1, designates an area estimated to consist of 250,000 tons of perlite. This material has been tested and was found to expand from a raw density of 96 lbs/cu. ft. to a "popped" density of 1½ to 10 lbs/cu. ft. This represents an average increase in volume of about 2000%, which indicates the perlite is suitable for commercial use. The question that remains is - could these deposits compete with other deposits? The deposits at Superior have dominated Arizona perlite production for some time and this situation is expected to continue. However, the expansion of western perlite markets and rising costs of transportation may require development of more strategically located deposits (5, p. 1136). The perlite deposits near Yucca are favorably situated to the Southern California and Las Vegas markets and future growth along the Colorado River could create a local market for the deposits; however, when these deposits might offer serious competition to the Superior deposits is not known.

The boundary of Perlite-2 was established on the basis of the reported occurrence of perlite beds in T. 22 & 23 N., R. 19 & 20 W. (4, p. 406).

Brucite 1

Brucite is a magnesium hydroxide mineral used in ceramics, refractories, textiles, rubber, and also as a source of magnesium metal. Little is known of future trends in the market for brucite, although the demand for magnesium metal is expected to increase because of increased use of light weight metals by the auto industry. It is also being anticipated that magnesium may replace aluminum in structural materials[1].

There are few commercial size deposits of brucite known in the United States. Included with these are the deposits near Oatman in Sections 7, 8, 17 and 18, T. 19 N., R. 20 W.; the only known deposits of brucite in Arizona.

Estimates of reserves range from 40,000 tons[2] to 500,000 tons[3]. One deposit was drilled a few years ago (probably middle or late 1960's) resulting in an estimate of 200,000 tons of reserves. There was limited production from the deposits around 1953, but the low grade of the ore ended further production. The deposits consist of some high grade material, but not enough to justify mining at present.

Several groups of unpatented claims cover the deposits. These include the Mag group, Whitehouse group, Midnight group, Pioneer group, and Moss Wash group. Other unpatented claims occur nearby partly because the area is within the Oatman Mining District.

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1. Engineering and Mining Journal, vol. 174, no. 3, March 1973, p. 120.
2. Mineral and Water Resources of Arizona; Arizona Bureau of Mines Bulletin 180, 1969, p. 324.
3. Compendium on Nonmetallic Minerals of Arizona; prepared by the Southwest Research Institute, San Antonio, Texas, 1964, p. 58.

Clay-1

Clays are a group of minerals with a wide variety of uses. Properties such as purity, resistance to high temperatures, bonding strength, and swelling capacity determine what the clay can be used for. Most clay mined in Arizona has been used for refractory and ceramic purposes. About 600,000 tons were mined in Arizona from 1962 to 1965.

Several clay deposits occur at the southern end of the Black Mountains, but little is known of their extent and quality. One deposit occurs on Federal land where the mineral estate is privately owned (E½SE¼ Sec. 35, T. 17 N., R. 19 W.). Reserves are reported to be large (2, p. 83), and tests have shown the material has desirable properties as refractory material (2, p. 83).

Sometime during the 1960's, the deposit was mined and the clay shipped by rail from the nearby Franconia siding. It is not known how much of the material was mined or how much still remains. According to Gerald Weathers, Consulting Geologist in Phoenix, the clay was used in the construction of an airport. There has been no mining activity at the deposit in the past several years and all improvements are in an advanced state of disrepair.

ARKLA was active in Clay-1 during the 1960's. They conducted geophysical exploration, drilling for gold veins and disseminated copper deposit, and they located a number of claims (Don claims).

References:

1. Compendium of Nonmetallic Metals of Arizona; prepared by the Southwest Research Institute, San Antonio, Texas 1964.

2. Mineral and Water Resources of Arizona; Arizona Bureau of Mines Bull. 180, 1969.

Affidavit of Labor Performed and Improvements Made

STATE OF ARIZONA, }
County of Mohave } ss.

Howard S. Gable being duly sworn, deposes and says that he is a citizen of the United States and more than twenty-one years of age, and resides at Kansas City, Jackson County, State of ~~Arizona~~ Missouri, and is personally acquainted with the mining claims known as Haviland Nos. 1 to 90, incl.

mining claims situate in San Francisco Mining District, County of Mohave, State of Arizona, the location notices of which is recorded in the office of the County Recorder of said County, in Books 192 & 226 of Records of Mines, at pages 59 to 90 & 939 to 996; that between the 2 day of September, A. D. 1974, and the 1 day of September A. D. 1975, at least Nine thousand ($9000.00) dollars worth of work and improvements were done and performed upon said claims not including the location work of said claim. Such work and improvements were made by and at the expense of Howard S. Gable owner of said claims for the purpose of complying with the laws of the United States pertaining to assessment of annual work, and Jack D. Day, Wayne L. Day, Thomas Skidmore, Mary J. Daily, Norman M. Buchan and Melvin H. Jones were the men employed by said owner and who labored upon said claims did said work and improvements, the same being as follows, to-wit:

1. Opened three (3) pits near the Santa Fe railroad and mined and stockpiled ore. $6000.00 (plus)
2. Road improvements. $1000.00 (plus)
3. Geological survey $2000.00

~~a Geological examination and study of all the Haviland claims.~~
b Physical investigation and study including examination of all pits, outcrops, drill holes. This includes mineral identification, sampling, assaying, research, stratigraphic study, mapping, studying drill hole logs, ore evaluation, inferred tonnage, and recommended action. The cost of this survey is in excess of $2000.00. Inferred tonnage 10 mt.
c Basic findings are that the Perlite on a major portion of the claims is of commercial grade and can be mined at the present time for a profit. Drilling and other development activities should be continued.
d Person making this geology survey is Melvin H. Jones, Registered Geologist, Principal office address: 425 S. 3rd St., Las Vegas, Nev.

REGISTERED GEOLOGIST Melvin H. Jones No. 841 STATE OF CALIFORNIA

Howard S. Gable

Subscribed and sworn to before me this 30th day of August A. D. 1975

Notary Public.

(My commission expires MY COMMISSION EXPIRES AUGUST 9, 1976.)

MELVIN H. JONES
Mining Geologist
~~Box 1, Montello, Nevada 89830~~

MHJ/j
Box 406,
Wickenburg, Ariz. 85358.
6 July 1975

Mr. Howard S. Gable
Box ~~649~~ 946
Kansas City, Mo. 64141

Dear Howard:

Reference our conversation concerning annual assessment labor on your 90 Haviland Perlite claims.

Suggest the following which can be used for valid work in Arizona:

a Open several small open pit cites on the property and stockpile some ore. Do this with a contract miner who has the necessary equipment - compressor, drill, and a small bulldozer. A contract for $6000.00

b In connection with the above operation, work over some of the bad areas on the roads with the small bulldozer. Cost. $1000.00

C Geology study. Summary and digest of all accumulated data. Some additional sampling and maping. Cost.$2000.00

Yours sincerely,

The following is extracted from an Arizona Bureau of mine publication and is very excellent to use in "eye balling" perlite on the Haviland, of other claims :

Physical and chemical properties	Expansion qualities good	same poor
Luster	Shiny or pearly	Dull
Fracture	Perlitic, columnar, or splintaryñshatters into sharp angular fragments.	Tendency to no perlitic andp shatters into granular or po y fragments
Marekanites (dark glass buttons	Presence is favorable indication, but not essential.	Absent
Specific Gravity	Predominately 2.33-2.40	Mostly 2.31-2.3(
Combined water plus H_2O	Predominately 3.0-4.2%	2.42 - 4.95%
Alkalinity (ph)	7.4 8.6(apparently not distintictive)	7.4 8.6
Indes of refraction	Apparently not distinctive	Apparently not distinctive)
Microscopic inclusions	Clear crystallites, bubbles and very fine dark particles	Little or no crystallites and bubblesñ may or not have very fine dark particles.
Phenocrysts	Minimum of phenocrysts, such as quartz, feldspar, and biotite	Abundant phenocryst

Box 406
Wickenburg, Arizona, 85358
12 April 1974

MEMORANDUM FOR THE RECORD

Subject: Visit to the Haviland Perlite claims, Yucca, Ariz.

The writer spent April 10-11, April 1974 on the Haviland Perlite claims located SW of Yucca, Arizona. Mrs. Pearl Craig, Kingman, Arizona, who has been doing most of the claim location work, was also present. Time was spent going over the claims (90 lode claims), examining posting of location notices, roads, and perlite exposures. The property is known to have pumaceous perlite and perlitic perlite (estimated to be 55 and 13 million tons, respectively). These claims were initially taken out by, Duval (copper) about 10 years ago under the claim names of Saguara, Chapo, Vulcan, Sliver, Dec. 21, DMC, Peta, Shorty, and subsequently abandoned (the property was drilled in 1964, however) Considerable time was spent by Mrs. Craig, and the writer locating the old drill holes (a total of 15). These will be mapped.

On April 11, Mr. Don Rodriguez, General Manager of the Metler Bros. Drilling Corporation, accompanyied us in going over the mining claims. Mr. Rodriguez will submitt an estimate of the cost to re-drill the property to cover location work requirements. Metler Bros. initially drilled the property in 1964 for Duval. He said the drilling at the time took 55 days. Mr. Rodriguez had some of the earlier drilling data with him and gave us the depths of overburden on the drill sites (length of casing used). See inclosure.

Upon arriving at Kingman on April 10th, I made a fast trip to the Duval plant(Northwest of Kingman). There I met and talked with Ronald F. Teissere, Duval geologist. I asked him the question, Why did Duval abandon the Yucca perlite claims ? His answer was, that "there is nothing wrong with the perlite ore, but the economic situtiom years ago, would not permit the mining and shipping of perlite at profit, then. Perhaps there is more demand for perlite, now".

CROSS REFERENCE TO JULY CLAIMS

Melvin H Jones
geologist

From the desk of ... Haviland Claims

DON RODRIGUEZ

Overburden in Feet.

D.H.		
#1 -	27.	H-1 — 10
2 -	35.	H-2 - 25
3 -	25	H-3 - 10
4 -	25	
5 -	25	
6 -	10	didn't see
7 -	10	
8 -	10	
9 -	5	
10 -	10	pieces of ore
11 -	10	
12 -	10	
13 -	10	
14 -	10	
15 -	10	

280-139

DUVAL CORPORATION
4715 EAST FORT LOWELL ROAD TUCSON ARIZONA 85712

May 3, 1974

Mrs. Pearl Craig
4180 Skylark Road
Kingman, Arizona 86401

Dear Mrs. Craig:

Pursuant to our telephone conversation about the Perlite exploration work this Company did in Mohave County about ten years ago I am enclosing copies of the following:

1. Assay-Geology Composite Logs on Holes Nos. 1 through 15 inclusive. (They are not very complete but may be of some help.)
2. Letter from U. S. Bureau of Mines Tucson Metallurgy Research Laboratory dated April 11, 1963.
3. Letter dated July 10, 1963, from Colorado School of Mines Research Foundation, Inc.
4. Letter dated August 21, 1964, from C.S.M. Research Foundation, Inc.
5. Converter Log - dated February 16, 1965.
6. Report - Arizona Perlite by Eldred D. Wilson and George H. Roseveare - Black Mountains (Mohave County) Deposits.

We do not guarantee the data included in the above but believe it to be OK.

Yours very truly,

DUVAL CORPORATION

1700 W. Washington.
542-5971

by: B. G. Messer

B. G. Messer
Vice President-Minerals Acquisition

BGM:rg
Enclosures

DUVAL
CORPORATION

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DUVAL CORPORATION

by: B G Messer

B. G. Messer
Vice President-Minerals Acquisition

BGM:rg
Enclosures

MELVIN H. JONES
Mining Geologist
~~Box 1, - Montello, Nevada 89830~~
Box 406, Wickenburg, Az. 85358.
12 July, 1974.

MEMORANDUM FOR THE RECORD.

SUBJECT: Haviland Perlite claims (owned by Mr. Howard S. Gable).

AT the request of Mr. Howard S. Gable, box 946, Kansas city, Mo., the writer made a trip to Kingman, Arizona (and then down to Yucca to the Haviland claims) on July 11, 1974.

A map had been located showing the mentioned perlite deposits when they were owned by the Duval Copper Company. Apparently this map was made by the Duval engineers. This map reveals all of the Duval claims and delineates the regions that have perlite. There is several large areas that have "pumaceous" perlite, and several much smaller regions with "perlitic" perlite. On the map is an inferred total tonnage of 5.3 million tons. No proven tonnage is shown. It had been understood in the past (from hearsay information) that there is 68 million tons of perlite on the claims ???

The writer, and Mr. Jack Day, then proceeded to the Haviland claims, with the said map, and examined several areas containing the "pumaceous" perlite and compared the material found there with other areas having "perlitic" perlite. At this point, it is well to mention that the perlitic perlite is of commercial grade. It is the typical glassey type with concentric cracks.

However, the so called "pumaceous" perlite is a different story. This more closely approximates a tuff, in the opinion of the writer. The term "pumaceous" implies the presence of pumice. Pumice should be like a sponge and be highly cellular, and is the result of explosive volcanic action, and it should still be glassey. A tuff, on the other hand is a volcanic ash and it can be compacted into solid rock and it is not glassey. On the other hand, the Perlite industry calls any rock that contains 2 to 5% water, and that can be expanded by heating, a perlite. Maybe its a matter of semantics. In any event, several samples of the so called pumaceous perlite should be obtained and tested without delay as to its commercial practicability. (Unless this has already been done by Mr. Gable and/or associates?).

Mr. Day checked the County Recorder's records and learned that the so called railroad sections, (adjoining the Haviland claims) had been held by the New Mexico and Arizona Land Company in the past. But they were relinquished on January 10, 1973 by said company (and returned to the RR company ?). He also ascertained the same information from the BLM office in Kingman.

Cores, from the current drilling program (which are in storage at a commercial sharehouse in Kingman) were also looked over by the writer. Only about 2 feet of perlitic perlite was noted, but there is much of the so called pumaceous perlite.

A study into the so-called perlite reserves, should be undertaken. To do this properly, much additional drilling is required. Also the "pumaceous" perlite should be tested in a laboratory.

xxxxxxxxxxxxxxxxxxx

P.O. box 406
Wickenburg, Arizona
85358
March 17, 1970.

Mr. Howard S. Gable
P.O.box 946
Kansas City, Mo.,64141

Dear Howard:

Reference is made to your 90 each Haviland (perlite) mining claims located near Yucca, Arizona that you recently filed on.

Under the mining laws and regulations in force in the State of Arizona, the required location work must now be accomplished on the mentioned lode claims. The following is quoted from the Department of Mineral Resources, State Of Arizona guide book (June 1970 issue):

"Within 120 days from the time of location, sink a location or Discovery shaft on the claim to a depth of at least eight feet from the lowest part of the rim of the shaft at the surface or deeper, if necessary, to a depth where mineral in place is disclosed in the shaft. The shaft should have a cross section of at least 4 ft. X 6 ft."

"An open cut, adit or tunnel, equal in amount of work to a shaft 8 feet deep and 4 feet wide by 6 feet long is equivalent as location work to a shaft sunk from the surface".

In lieu of the requirements above, and within 120 days from the time of location, may:

"Do location work consisting of drilling not less than 10 feet in depth in any one hole, costing at least $100.00 for the actual doing of such drilling at the point where done. Work performed by the locator himself or equipment furnished by him shall be credited to such cost at the prevailing rate in the district for the type of work or equipment so done. Such drilling may be done at one or more points within a claim(or group of claims that are contiguous) providing all such claims are so located that the entire area of the groupp can be contained within the exterior limits of a square 3000 feet long, by 3000 feet wide, if the drilling so done for the group aggregates not less than 10 feet for each claim (and at a cost of not less than $100.00 for each claim).

"Each drill hole will be capped (and markers affixed). Make a map of drill holes and submitt same to County Recorder with an affidavit outlining all facts - - - - -".

Best of personal regards, Sincerely,

ARIZONA PERLITE

BY

ELDRED D. WILSON * AND GEORGE H. ROSEVEARE**

Black Mountains (Mohave County) Deposits

Large deposits of perlite have been found in the southern and middle portions of the Black Mountains, of western Mohave County. Another deposit is reported to occur in the northwestern portion of this range, near Eldorado Canyon.

Separated from the Muddy Mountains of Nevada by Boulder Canyon, the Black Mountains extend southward for 100 miles to Sacramento Wash. The southern end of the range is skirted by the Santa Fe railway and is also accessible from the Yucca-Topock road. U. S. Highway 66 crosses the southern portion of the range through the Oatman gold district, and the Kingman-Bullshead highway leads through the Union Pass and Katherine gold districts, 12 miles farther north. The middle portion of the range is accessible from the Boulder dam highway by roads that lead to the Producers mine.

The topography of the southern end of the range is shown on U. S. Geological Survey Yucca and Needles sheets. An outline of the general geology of the Black Mountains and detailed descriptions of the Oatman and Katherine districts have been published. (10)

The Black Mountains rise in altitude from 1,100 feet at their southern base to 5,500 on their highest northern peaks. Much of their surface is steep and very rugged. The southern and middle portions of the range consist largely of Tertiary volcanic rocks which in places are seen resting upon granite, gneiss, and schist. This volcanic series, totalling 8,000 to 10,000 feet in thickness (10) consists largely of trachyte, andesite, latite, tuff, and basalt. Intrusive into parts of this series are porphyries of granitic to monzonitic composition. The volcanic series as a whole dips gently eastward and is cut by numerous faults of prevailingly northwestward strike. (10)

The perlite, 25 to more than 100 feet thick, occurs in the upper portion of this volcanic series. It forms exposures several hundred square feet in area at many places and extends for undetermined distances beneath breccia, tuff, latite, and basalt.

Southern area: In the southernmost portion of the Black Mountains perlite crops out in secs. 22, 26, 27, 28, 34, and 35, T. 17 N., R. 18 W. These deposits, north of Haviland and southwest of Yucca, are within 3/4 to 2 miles of the Santa Fe railway.

In the northern portion of sec. 27, the following succession extends upward from the valley fill (thicknesses estimated): (1), tuff and breccia containing angular boulders of perlite up to more than 6 feet in diameter, 400 feet thick; (2) perlite, 90 to 150 feet; latite breccia, 35 to 50 feet; (3) latite, 50 feet; pumiceous glass and tuff, 90 feet; (4), latite, capped by basalt northward, 60 feet.

The perlite of this area contains phenocrysts of quartz ranging up to about 0.1 inch in diameter.

Southward the volcanic series dips gently southeastward and is displaced somewhat by faults of northwest strike. On the west bank of Sacramento Wash, in sec. 35, the breccia-perlite lower contact dips beneath the surface. Here the perlite crops out mainly as an oblong area about 100 feet long by a maximum of 75 feet wide. It forms a mass approximately 150 feet in thickness of which the lowest 50 feet is relatively pure perlite showing some quartz phenocrysts; its middle 50 feet contains several layers of spherulitic rhyolite; and the upper 50 feet consists of alternating bands of perlite and latite. Intrusive latite forming the crest of the ridge is in contact with this perlite mass on the west.

Middle area: Perlite occurs in the eastern middle portion of the Black Mountains, particularly in T. 22 and 23 N., R. 19 and 20 W. It crops out intermittently along the ridges that extend east of the pipeline road, for 3 miles south of the Producers mine.

The volcanic series containing perlite is well exposed in an eastward-tilted fault-block ridge one mile southwest of the Producers mine. Here the following section from west to east was measured: (1), latite, 150 feet exposed; (2), dark-gray tuff and mudstone, 35 feet; (3), dark-gray glass with granular fracture, 10 feet; (4), brown cellular latite, 40 feet; (5), talus covered, 150 feet, with 8 feet of coarse tuff exposed; (6), fine-grained tuff, 80 feet; (7), tuff and breccia with fragments of perlite up to more than a foot in diameter, 15 feet; (8), perlite, 12 feet; (9), alternating bands of perlite and tuff, 25 feet; (10), tuff and breccia of perlite fragments, 30 feet; (11), fine-grained tuff, 30 feet; (12), cellular basalt flow, 8 feet; (13), fine-grained tuff and breccia of perlite fragments, 30 feet; (14), black perlite, 3 to 30 feet; (15), platy rhyolite, 75 feet.

East of the windmills in sec. 2, T. 22 N., R. 20 W., a mass of perlite approximately 50 feet thick and dipping 30° west overlies thick volcanic breccia and underlies tuff. This outcrop extends southward for approximately 1/4 mile. Its upper 25 feet contains bands of latite.

DUVAL CORPORATION

4715 EAST FORT LOWELL ROAD TUCSON ARIZONA 85712

May 3, 1974

Mrs. Pearl Craig
4180 Skylark Road
Kingman, Arizona 86401

Dear Mrs. Craig:

Pursuant to our telephone conversation about the Perlite exploration work this Company did in Mohave County about ten years ago I am enclosing copies of the following:

1. Assay-Geology Composite Logs on Holes Nos. 1 through 15 inclusive. (They are not very complete but may be of some help.)
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Yours very truly,

DUVAL CORPORATION

by: B. G. Messer

B. G. Messer
Vice President-Minerals Acquisition

BGM:rg
Enclosures

ASSAY— GEOLOGY COMPOSITE LOG

Sheet of

BEARING	Coord. : N	HOLE NO 1
INCL. Vert.	E	COLLAR ELEV. 1500'
	Vulcan 5	DEPTH 80

DESCRIPTION	% Cu	c/o As Cu	% Mo	% As Mo	% EQIV			CROSSING — RMKS
Felsic dyke overburden (Q), Qb No core recovered.								

SCAY—GEOLOGY COMPOSITE LOG

Sheet 1

BEARING INCL. 45°	Coord. : N E Elev. [illegible]	HOLE NO. 2 COLLAR ELEV. [illegible] DEPTH 36

DESCRIPTION	% Cu	% Acid Cu	% Mo	% Acid Mo	% EQIV.			GROUPING — REMARKS
No Core recovered. Overburden? Gr								

DRILL HOLE LOG

DUVAL SULPHUR & POTASH COMPANY

HOLE NO. 3

PROJECT Haviland Perlite SIZE NX TYPE

LOCATION Vulcan 20 Claim START 11/3/64

N E ELEV. 1670' T.D. = 90' STOP 11/4/64

FROM	TO	INTERVAL	RECOVERY	CHARACTER	REMARKS
0	15	15	0		Rock bit
15	20	5	15	Spherulitic welded tuff(?),	
20	24	4	0	purple-grey color.	
24	26	2	95	pink argillized, pumiceous perlite tuff agglomerate (PePu)	
				Noticable biotite content.	
26	32	6	100	occasional chunks of rhyolite(?)	
32	35	3	66	PePu, less pink argillaceous material	
				with depth.	
35	45	10	60	-do-	
45	46	1	100	-do-	
46	48	2	100	Blue-grey perlite	
48	55	7	100	Slightly argillized perlite tuff agglomerate.	
				More perlite & less pumice noted.	
55	58	3	100	-do-	
58	64	7	100	Vitric lithic tuff agglomerate.	
				Agglomeratic inclusions = ½" - ¾" average	
64	74	10	100	Noticable increase in 1" pumice	
				fragments 70' - 72'	
74	84	10	100	-do-	
84	90	6	100	-do	

LOGGED BY

FORM NO. 355

DRILL HOLE LOG

DUVAL SULPHUR & POTASH COMPANY

HOLE NO. 4

PROJECT Haviland Perlite SIZE NX TYPE

LOCATION Chapo Claim START 11/6/64

N E ELEV 1500 T.D. = 90' STOP 11/10/64

FROM	TO	INTERVAL	RECOVERY	CHARACTER	REMARKS
0	35	35	0		Rock bit
35	43	8	5%	Perlite - pumice - rhyolite (?) tuff	
43	46	3	100	conglomerate with fragments	
46	56	10	55%	2" to sand size fragments	
56	58	2	100	average ½".	
58	66	8	100	Spherulitic perlite. Dark grey perlite with >50% lithic material (mostly brown rhyolite (?) spherulites in bands + some blue opal)	
66	76	10	95	-do-	
76	83.5	7.5	100	-do. Note that the rock gradually becomes more rhyolitic (?) with depth	
83.5	90	6.5	90	-do-	

WHILE WE BELIEVE THIS INFORMATION TO BE CORRECT, WE MAKE NO REPRESENTATION WITH RESPECT TO, NOR DO WE ASSUME ANY RESPONSIBILITY FOR, THE CORRECTNESS THEREOF.

DUVAL CORPORATION

LOGGED BY

ASSAY - GEOLOGY COMPOS[illegible]E LOG

Sheet of

BEARING	Coord. : N	HOLE Nº 5
INCL. *Vertical*	E	COLLAR ELEV.
	Shorty 2	DEPTH *70'*

DESCRIPTION				C.G.	% Cu	% AsCu	% Mo	% AsMo	% EQIV.			GROUPING — RMKS
Rock bit to 25' thru spherulitic Rhyolite												
25-26' Spherulitic perlite												
26'-30' Sph. W.T												
30-41' W.T. Ash fall thin bedded lithophysae to ½" dia.												
41'-70' W.T. [illegible] with fine lith. [illegible] less than ⅛".												
Bedding dipping @ ~25° near top flattens to ~10°												
T.D. 70'												

6

ASSAY—GEOLOGY COMPOSITE LOG

Sheet of

BEARING	Coord.: N
INCL.	E
	Saguaro "27" S(U)

HOLE No 6
COLLAR ELEV.
DEPTH 100'

DESCRIPTION				% Cu	% As Cu	% Mo	% As Mo	% EQIV.			REMARKS
0-100' (D) Shattered Pumice Block flow tuff appears to be ...											

WHILE WE BELIEVE THIS INFORMATION TO BE CORRECT, WE MAKE NO REPRESENTATION WITH RESPECT TO, NOR DO WE ASSUME ANY RESPONSIBILITY FOR, THE CORRECTNESS THEREOF.
DUVAL CORPORATION

ASSAY–GEOLOGY COMPOSIT LOG

Sheet

BEARING	Coord. : N	HOLE NO 7
INCL.	E	COLLAR ELEV.
	Collared 23-24	DEPTH 35'

DESCRIPTION	% Cu	% AsCu	% Mo	% AsMo	% EQIV	CORING — WASH
Qb – Vesicular Basalt Boulders and LS Gravel Cobbles for TD 35'						

ASSAY—GEOLOGY COMPOSITE LOG

BEARING	Coord. : N	HOLE Nº 8
INCL.	E	COLLAR ELEV.
		DEPTH 205

DESCRIPTION			WT.	% Cu	% As Cu	% Mo	% As Mo	% EQIV			GROUP REMARKS
0-45.5' Qb. — Pu excellent quality — Pu block flow just to. of bio.											
161-167 Tuff bed. Fine grained bio w little lithic lapilli											
167- 205 TD Pu block flow.											

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ASSAY—GEOLOGY COMPOSITE LOG

Sheet of

BEARING	Coord.: N	HOLE No 9
INCL.	E	COLLAR ELEV.
	DH #15	DEPTH 160'

DESCRIPTION	%Cu	%AsCu	%Mo	%AsMo	%COM.			GROUPING—RMKS
0-1?' - Qb Basalt Bldrs & "Caliche"								
T[illegible] - Blue "Naoma type" Splotch [illegible]								
Transitional [illegible] Porphyry [illegible] Blu[illegible] [illegible]								
92' Flow [illegible] / at [illegible] too much / Lithic [illegible] / Por[illegible] / [illegible] Flow / [illegible] Mo / [illegible] (15?)								

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ASSAY—GEOLOGY COMPOSITE LOG

Sheet #1

BEARING	Coord : N	HOLE NO 10
INCL.	E	COLLAR ELEV.
	Square	DEPTH 160

DESCRIPTION	FROM	TO	% Cu	% AsCu	% Mo	% AsMo	% EQIV.		GROUTING - AMTS.
Vesicular basalt "Paradise Formation"	0	27							
Punsie Tuff. Probably N.G.									
								100'	

ASSAY— GEOLOGY COMPOSITE LOG

Sheet of

BEARING
INCL.
Coord. : N
E

HOLE No 11
COLLAR ELEV.
DEPTH 95

DESCRIPTION			% Cu	% AsCu	% Mo	% [illegible]	% EQIV.		

0–10½'
[illegible].
[illegible] SOFT [illegible].

Pipe - Probably
Commercial to
T.D. = 95'

T.D. 95'

10

ASSAY—GEOLOGY COMPOSITE LOG

Sheet of

BEARING
INCL.

Coord. : N
E

Fcta #

HOLE Nº 12
COLLAR ELEV.
DEPTH 40

DESCRIPTION				% Cu	% As Cu	% Mo	% As Mo	% EQIV			GROUPING — RMKS
Pe[illegible]											
Pink [illegible] blek [illegible] [illegible] matrx Partially [illegible] Gets [illegible]. Pink color [illegible] to very pale @ 40.											

ASSAY—GEOLOGY COMPOSITE LOG

Sheet of

BEARING	Coord. : N	HOLE Nº 13
INCL.	E	COLLAR ELEV.
	Pete #3 [illegible]	DEPTH 35

DESCRIPTION	[illegible]	[illegible]	[illegible]	[illegible]	% Cu	% As Cu	% Mo	% As Mo	% EQIV.			GROUPING — RMKS
Overburden Qb — Ground [illegible]												
[illegible] [illegible] - [illegible] fused [illegible] - [illegible] vesicle 12 - 26												[illegible] [illegible] [illegible] [illegible] [illegible] recon
Tarnish [illegible] [illegible] - [illegible] commercial quality some [illegible] but not much feldspar 33 - 34 feet - [illegible] fractures.												

ASSAY—GEOLOGY COMPOSITE LOG

Sheet #

CASING	Coord. : N	HOLE NO. 14
W.L.	E	COLLAR ELEV.
	Pete	DEPTH 85

DESCRIPTION	% Cu	% AsCu	% Mo	% SolMo	% SOL.		
Py Po from top to bottom - Mineralization varies depending on faces of fracture							

ASSAY—GEOLOGY COMPOSITE LOG

BEARING
INCL. Vert
Coord. N
E
HOLE NO
COLLAR ELEV.
DEPTH

DESCRIPTION				% Cu	% AsCu	% Mo	% AsMo	% EQIV			
Pale Gray Bio Perlite											
Argillite with Schwaldes <5%											150
Argillite											

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