

Proceedings of the  
48th Annual Forum on the  
Geology of Industrial Minerals  
Scottsdale, Arizona | April 30 - May 4, 2012



Pinite in Nevada, and why it might be of interest  
David L. Crouse and Patrick Embree

Arizona Geological Survey  
Special Paper 9  
Chapter # 5

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Arizona Geological Survey

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**Suggested Citation:** Crouse, D.L, and Embree, P., 2014, Pinite in Nevada, and why it might be of interest, in, Conway, F.M., ed., Proceedings of the 48th Annual Forum on the Geology of Industrial Minerals, Phoenix, Arizona, April 30 - May 4, 2012. Arizona Geological Survey Special Paper #9, Chapter 5, p. 1-8.

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# Pinite in Nevada, and why it might be of interest

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## Abstract

Pinite is a compact, fine-grained, usually amorphous mica as defined by the AGI glossary. It is also a term that has been used to identify metamorphic rock that is the result of the retrograde decomposition of cordierite-altered volcanic rocks, resulting in an impure micaceous rock that may contain pyrophyllite. Various definitions of the term and limited occurrences of this material make it somewhat of an unknown in the field. An occurrence of pinite near Lovelock, Nevada, that was once exploited for refractory brick manufacturing during World War II, was recently evaluated for commercial applications that are typically sourced from chlorite or talc mineral products. The pinite at this location has a brightness in the mid-80s, consistent mineralogy, very low quartz content, a platy morphology and works well in coatings formulations. The development of this resource could provide product that might possibly replace other platy mineral products in coatings product formulations.

## Introduction

An effort by the author to identify and develop new sources of chlorite in the western United State has focused on various districts in southwestern Montana, southern Nevada and the Mojave of California. To date, no potential deposits have been identified with suitable color, mineralogy or tonnage. Following the Forum of 2007, at which I presented a paper on the Chlorite occurrences of the western United States, I received a sample from the pinite claims in Nevada from Pat Embree, who had seen the presentation. The sample was of a rock type unfamiliar to me and appeared to be a bit too hard and too gray for what we were looking for. Initially, I found very little in the literature on pinite to encourage me to further evaluate the sample or deposit. Later, after I stumbled upon Papke's description of the Pinite Mine in his 1975 publication on talcose minerals, my interest was piqued. After lab analyses and an initial site

evaluation, we further evaluated the project. We strongly believe that there is potential for this type of rock occurrence to be the new "chlorite" that we were looking to identify.

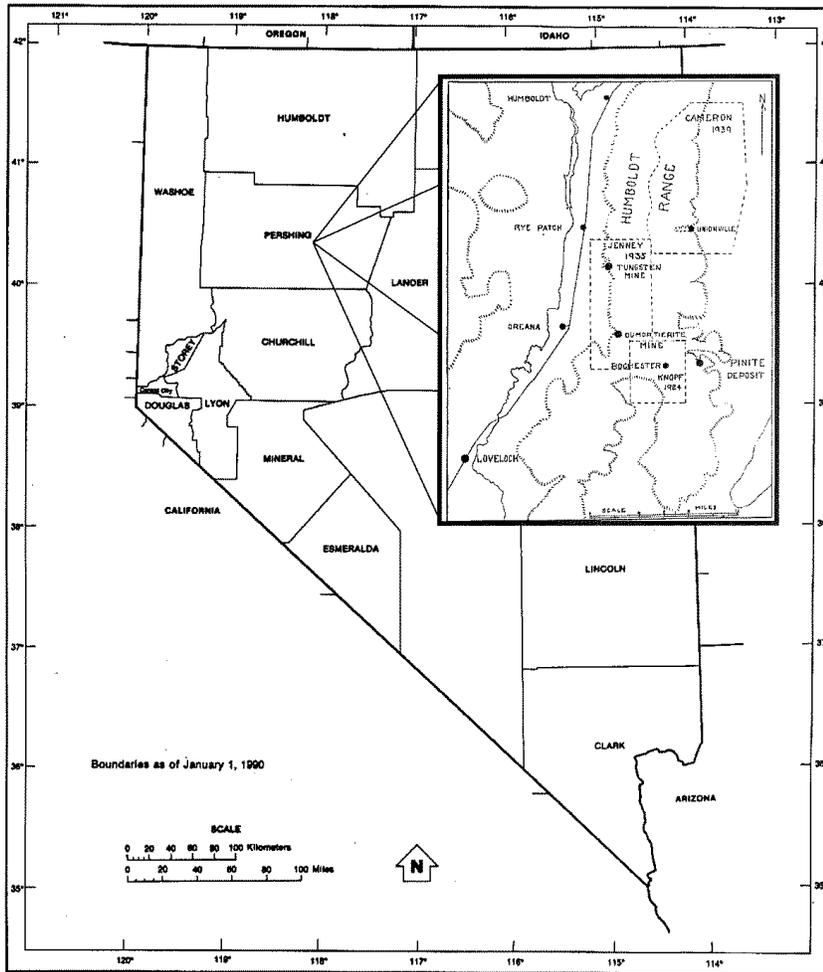
## Location

The Pinite mine and related claims are located on the east side of the Humboldt Range, Pershing County, Nevada (sec. 19, T. 28 N., R. 35 E.). The original mine is covered by the Bullhead patented claim, with the extent of mineralization covered by six of the Pinite lode claims. The property is 15 miles by road east of Oreana, Nevada. The mine is on the upper west side of a north-south trending ridge on the south side of South American Canyon. The pinite is found within the Spring Valley District, just east of the Rochester District.

## History

What eventually became the Pinite Mine was apparently discovered around 1933 on the eastern side of the Humboldt Range in Pershing County, Nevada, by George Fisk (personal communication, Fisk, 2009). By the time Paul Kerr (1940) first described the occurrence in 1938, there were several workings opened up and several carloads of ore had been shipped. The property was mined actively from 1938 until 1944, and then again briefly in 1947-48. It was estimated that as much as 10,000 tons of ore was produced from the property.

The Pinite Mine is on the Bullhead Lode claim which was patented in 1954 (Papke, 1975). Mining was conducted by Gladding, McBean and Co. and the property was later held by a successor company known as Interpace Corporation, after the company merged with the Lock Joint Pipe Company in 1962. Gladding, McBean and Co. was founded in 1875 in northern California and was a well known producer of pipe, terra cotta, fire bricks and pottery.



**Figure 1.** Location of the Pinite Deposit, Pershing County, Nevada (after Kerr, 1940).

Most of the ore extracted from the mine was shipped to Pittsburg, California, where it was processed and calcined to produce refractory bricks at the Gladding, McBean and Co. plant. The bricks were used primarily in the lining of rotary kilns for cement plants in northern California. In 2002, local prospector, Bob Walker acquired the patented claim from Star Hill Jr. with the idea of producing Pinite as a carving media. The patented claim and a group of surrounding claims are still held by Mr. Walker and his partners.

## Geology

The geology of the Humboldt Range has been described by numerous authors as a result of the historic silver-gold-zinc mineralization within the district. The alteration that led to the pinite mineralization here is undoubtedly related to the source of the alteration within the adjacent district.

Johnson (1977) reported that the pinite mineralization occurs within quartz sericite tuffs or ash falls of the Koipato Group that were subjected to later hydrothermal alteration. The Koipato Group, as presently defined, comprises the Limerick Greenstone, the Rochester Rhyolite, and the Weaver Rhyolite, all of Triassic age. It is within the Weaver section that the pinite mineralization primarily occurs. The Weaver Rhyolite overlies the lithologically similar Rochester Rhyolite and is as much as 2000 feet thick. The Weaver contains a higher percentage of phenocrysts and a greater amount of tuffaceous sedimentary rocks. The uppermost part of the Weaver consists of pale-colored flows and subordinate tuffs. A granodiorite stock intruded the Koipato Group during the Jurassic and is likely related to the hydrothermal alteration of the rhyolites. The region was later anticlinally folded and then faulted during the Cenozoic Basin and Range deformation.

Kerr (1940) originally believed that the pinite zone within the area of interest, underlaid the Rochester “Trachyte” and associated coarse tuff

and breccia, and represents an original fine tuff or ash. Papke (1975), however, locates the pinite zone within the “Permian” (Triassic) Weaver Rhyolite on a ridge capped by Triassic Prida Formation dolomite. He noted that the silty and sandy tuffaceous beds of the Weaver Rhyolite had been silicified. The ore zone occurs along what appears to be a fault within the hanging wall dipping at 55° to the east, within bedding dipping approximately 50° to the east. The ore body conforms mostly to bedding and may have been the result of selective hydrothermal alteration with alumina-rich fluids within a favorable zone.

Campbell (1939) believed that the Weaver Rhyolite and Prida Formation were folded into a broad arch and cut by granitic intrusives. Folding and intrusion are thought to have taken place at the end of the Jurassic. The structural features of the region occurred in two episodes, the earlier coincided with post-Jurassic tectonism and the second event took place in the

Tertiary, when extensive block faulting uplifted the Humboldt Range and initiated the present topography. The Bonanza King mine, 5 miles to the north of the Pinite Mine, within the Spring Valley District, contains a similar section of volcanic rocks. The post intrusive alteration of dikes and igneous rocks is primarily sericitization and carbonatization. The sericite was formed chiefly from the feldspars with associated fine-grained quartz. Mineralizing solutions were probably derived from the granodiorite intrusive exposed in Spring Valley. Most of the faults in the region strike N-S with an easterly dip. Cross faults in the area were formed as a result of the overthrusting along the NE-SW trending fault that lies to the north of the Pinite Mine (Figure 2).

An unaltered section of the Weaver Rhyolite occurs in a canyon to the east of the Pinite Mine near Fossil Hill (Figure 3a) and displays the original character of the silicified rhyolites within the formation. The authors believe that these rhyolites are mostly likely the parent rock units that have been replaced by pinite (Figure 3b), rather than the suggested silicified volcanoclastic sedimentary section.

## Alteration

It is likely that the granodiorite intruded into the region during the Jurassic, provided the mineralizing fluids which both generated the silicification of the Weaver Rhyolite and the subsequent hydrothermal metasomatism, which replaced the silicified volcanics with sericite and pyrophyllite. The fluids in this part of the district appear to have been controlled by north-south trending fault systems; the faults that cut sub-parallel to the metasomatized section controlled the localized alteration.

We suggest that the alteration sequence started with the silicification of the Weaver Rhyolite, which increased the silica content of the rock with decreased potassium and alumina content, and concluded with the formation of pyrophyllite and sericite with increased alumina and lower silica levels (Table 1). Hydrothermal alteration of the rhyolitic rocks is widespread and consists chiefly of the development of sericite and fine-grained quartz (Campbell, 1939). Sericite is abundant in all of the samples with pyrophyllite common and quartz minor. Pyrite and limonite are present in the upper portion and the southern extent of the mineralized area.

If the chemistry of the constituents is reviewed, it is possible to propose that the silicified rhyolite was pyrophyllitized and then sericitized. This would involve an increasing contribution of alumina in the system and an overall reduction in silica. The southern Humboldt Range is known to contain a province of alumina-rich hydrothermal occurrences including dumortierite and andalusite deposits, and common sericitization (Papke, 1975). In the North Carolina pyrophyllite deposits, the mineralization follows a path of silicification of the tuffs and breccias, with subsequent pyrophyllite formation and sericite forming along with the pyrophyllite or immediately after (Stuckey, 1958). With silica levels in the pinite of 50-52%, there is no free silica to form quartz.

Rhyolite > silicification > influx alumina/outflow silica > sericite + pyrophyllite

## Chemistry

There are only a few referenced locations of pinite and Table 2 contrasts the chemistry of the various known locations. We know from our work in Nevada that if the silica content is around 50%, that there will be minimal quartz content, and the ratio of sericite to pyrophyllite will be about 1:1.

## Mineralogy

The term pinite appears to have been derived around the year 1800 from the name of a mine in Saxony, Germany called Pini, which contained a variety of rocks with a composition of primarily muscovite mica. In early usage the name was predominantly used as a mineral term to describe amorphous, fine-grained or pseudomorphs of mica. The Glossary of Geology (Bates and Jackson, 1980) defines pinite as a compact, fine-grained, usually amorphous mica, (chiefly muscovite) of a dull-gray, green, or brown color, derived from the alteration of other minerals (such as cordierite, nepheline, scapolite, spodumene or feldspar). In later usage, mostly after Buddington's (1916) paper on pinite in Newfoundland, the term has been used to define a rock type. The primary constituents of the pinite in Pershing County, Nevada is sericite with minor pyrophyllite and quartz, and occasional andalusite as noted by Kerr (1940).

## Pyrophyllite Mineralogy

The mineralogy of known and documented pyrophyllite deposits typically show that the potential ore contains not only pyrophyllite, but commonly quartz, sericite, andalusite, kaolinite and diaspore. Minor quantities of rutile and pyrite are not unusual. It is our impression that the typical abrasive gangue minerals within commercial pyrophyllite products limit many of the potential filler applications due to the cost of beneficiation required to purify the final product.

We believe that the mineralogy of the potential ore on this property, with only trace amounts of quartz and no other measurable gangue minerals, is unique. A composition of nearly 50% sericite and 50% pyrophyllite provides an opportunity for low-cost, simple ore control and processing that would produce a uniform, non-abrasive, platy mineral product.

## Applications

Original applications for the pinite ore and product out of Nevada was in refractory bricks or in other brick and tile functions. Similar in function and application to chlorite products, the pinite fires white, exhibits extreme hardness and resistance to abrasion after firing, low shrinkage, low temperature inversion to mullite and relatively low and uniform thermal expansion (Page, et. al., 1940). Today, the low quartz content, moderate whiteness and platy morphology of the Nevada pinite could be attractive in coatings applications into which mica or chlorite products are currently formulated.

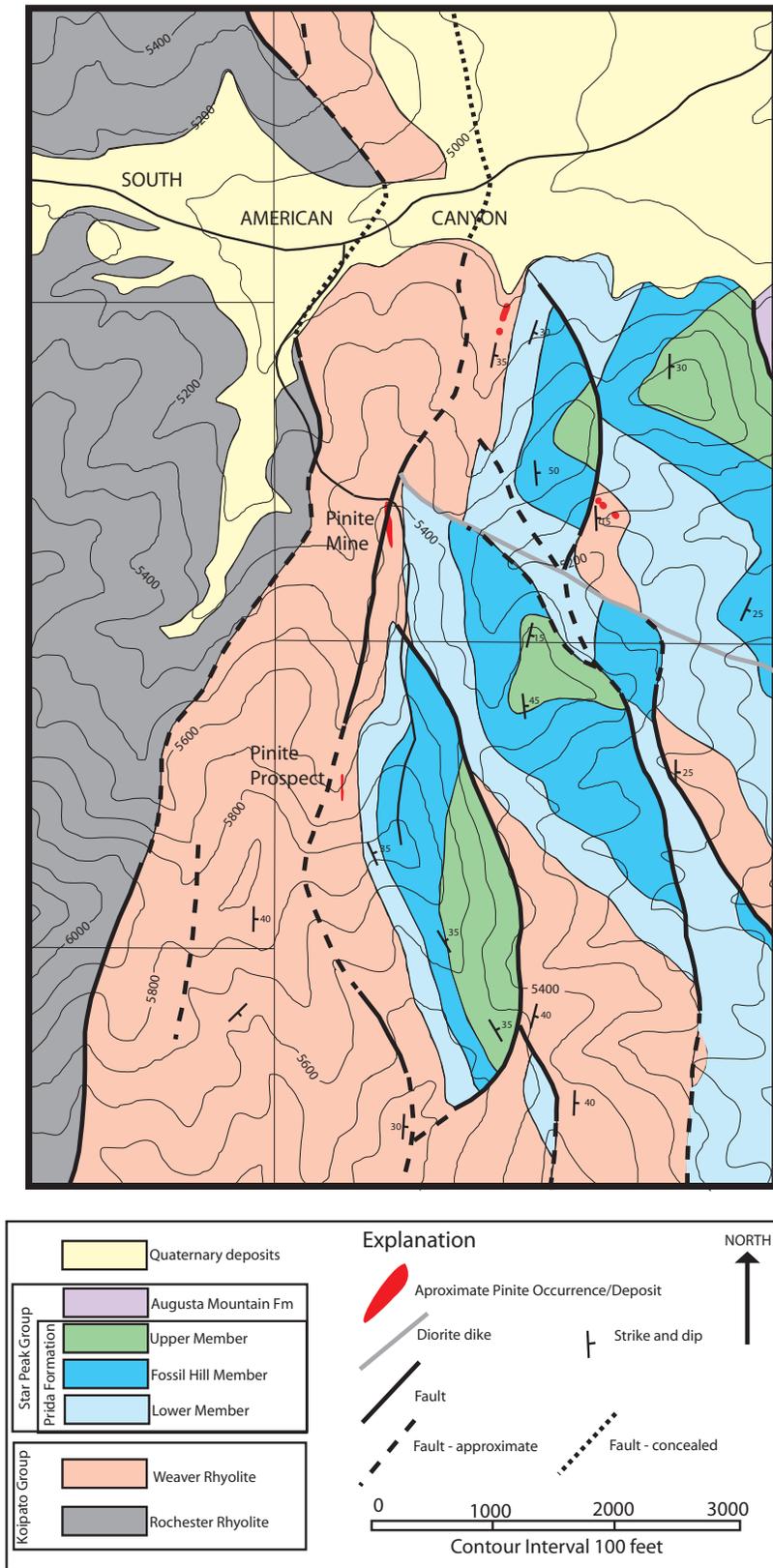


Figure 2. Geologic map of the Pinite mine area.



**Figure 3a (left).** Silicified rhyolite within the Weaver Rhyolite. 3b (right). Pinite mineralization.

**Table 1.** Chemistry of Parent Rock and Alteration Products.

	Weaver Rhyolite	Silicified Rhyolite	Pyrophyllite	Sericite	Pinite
Al <sub>2</sub> O <sub>3</sub>	13%	9%	28%	39%	34%
K <sub>2</sub> O	10%	5%	0	11%	8%
SiO <sub>2</sub>	75%	82%	68%	46%	52%
LOI	0	0	5%	5%	5%

## Project Status

Work on this project was discontinued in late 2008 as a result of a combination of a corporate mood for industrial minerals divestiture and the slow down in the economy. The claims are still held and controlled by the owners, with the next logical step in the project to be definition drilling to define the extension and continuity of the pinite mineralization.

## Conclusions

Pinite is not a widely known rock type, but the occurrence of this low-quartz sericite pyrophyllite resource could justify further evaluation to determine if sufficient quantities of the material is present for commercial development. It would appear that there is potential for the formulation of pinite into coatings or other applications where platy mineral products are currently utilized. We also know of a similar

lithologic occurrence in Jalisco, Mexico, so other exploration and development opportunities also may exist in similar volcanic terranes.

with me in Nevada. I also want to acknowledge Dr. Richard Berg for his review and critical comments that improved the content of the paper.

## Acknowledgements

I would like to thank Pat Embree for bringing this project to my attention and sharing field time

**Table 2.** Chemistry of various pinite occurrences. XRF analyses.

	Weaver Rhyolite	Nevada <sup>1</sup>	Nevada <sup>2</sup>	Canada <sup>3</sup>	Cornwall <sup>4</sup>	Germany <sup>5</sup>	Germany <sup>6</sup>
Al <sub>2</sub> O <sub>3</sub>	13.40	34.74	31.74	27.14	38.80	28.11	27.66
CaO	0.08	0.03	0.01	0.81	0.24	0.62	2.32
Fe <sub>2</sub> O <sub>3</sub>	0.30	0.11	0.08	2.58	0.50	8.08	5.97
K <sub>2</sub> O	9.60	9.25	4.59	8.01	8.09	1.54	0.64
MgO	0.13	0.44	0.27	2.44	0.16	9.10	3.07
Na <sub>2</sub> O	0.30	0.34	0.22	0.68	0.01	0.05	0.12
SiO <sub>2</sub>	75.00	50.00	57.97	54.47	45.90	41.18	40.74

1 - Pinite Mine, light gray. (Rio Tinto internal documents)  
 2 - Pinite Mine, dark gray. (Rio Tinto internal documents)  
 3 - Newfoundland, Conception Bay. (Buddington, 1916)  
 4 - Breage, Cornwall. (Collins, 1891)  
 5 - Schwarzwald. (Ogiermann, 2002)  
 6 - Bayerischer Wald. (Ogiermann, 2002)

**Table 3.** Mineralogy of Pyrophyllite deposits.

	Turkey (1)		North Carolina (2,3)		Japan (4)		Korea (5)	
	Type A	Type D	M3-A	Typical	Zone 4	Zone 5	Zone 1	Zone 2
Pyrophyllite	major	major	major	major	-	major	major	major
Sericite	-	minor			major	minor	-	-
Quartz	-	-	major	trace	minor	minor	-	minor
Kaolinite	-	-			-	minor	major	major
Diaspore	-	-			-	minor	minor	-
Andalusite	-	-	trace		-	-	-	-
Kyanite	major	-			-	-	-	-
Topaz	-	-			-	-	-	-
Feldspar	-	minor			-	-	-	-
Pyrite	-	-			trace	trace	-	-
Rutile	-	-			trace	trace	-	-

1. Uygun & Solakoglu, 2002; 2. Sykes & Moody, 1978; 3. Stuckey, 1958; 4. Nabetani & Shikazono, 2002.; 5. Takagi, et al., 2000.

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