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Geoscience Innovation through Research, Development, Consulting, Field Trips and Education

Rock sample analysis from a presumed archaeological site of an apparent lost civilization near Alamo in Lincoln County, Nevada

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prepared / approved by
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for

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SAMPLE INFORMATION and ANALYTICAL REQUEST:

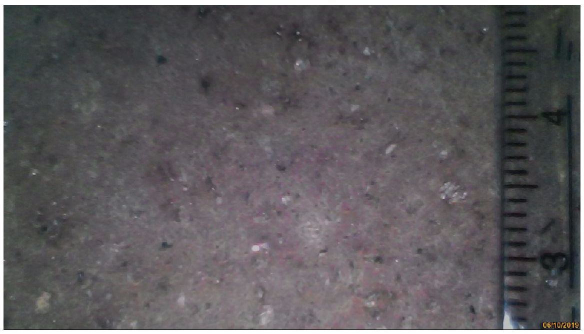
Request:

Predominately two questions were requested to be answered through a geological assessment of a rock specimens believed to be part of an archeological site.

1. How long is its History?
2. Its manufacturing process?

The importance of the geological assessment without any archeological interpretation was emphasized.

Sample Description:



Fresh or broken surfaces show a light brown to tan aphanitic (small grained) to porphyritic (with random crystals) texture with up to 2mm euhedral or well formed crystals. Some of the sample shows versicles (bubbles) of up to 5 mm in size, especially on what appears to be cut surfaces. Vesicles make up about 5% of the exposed rock surface. Weathered sample surfaces are a darker grey-brown with an occasional white-gray calcareous coating, which reacts vigorously with acid. It is presumed that the white coating formed on the underside of the sample where it was in contact with the ground, as is observed in many volcanic rocks. Exposed rock surfaces show the beginning of desert varnish development, a dark staining caused through secretion of black manganese oxides by bacterial colonies.

Where found:

The archaeological sample site is near Alamo in Lincoln County, Nevada, between the U.S.National Nuclear Test Site and Area 51. It is located within the Pahroc Valley about 4.5 km (2.8 mi) due South of the Great Basin Highway US93 between Caliente and Crystal Springs, NV and about 0.9 km (0.5 mi) East of the Pahroc Perlite Mine road.
GPS coordinates are N 37°34'29" and W 114°58'55" .
The USPLS locality description is the SE 1/4 of the NW 1/4 of Sec 25 in T4S and R62E.

Introduction

As part of the analytical services provided, the sample was subjected to the following assessments:

Non-destructive physical tests included observations of color, fracture /cleavage patterns, hardness testing, assessment of specific gravity, and streak evaluation. Additional analysis consisted of ultraviolet light reaction, both short and longwave, testing for radioactivity and magnetic response, organoleptic (smell, taste) assessment, and effervescence (reaction to dilute acid).

Included is also a destructive wet geochemical analysis of materials which allows for a more precise resolution of chemical species present and / or classification of the submitted material. This requires for the sample to be destroyed as it is dissolved and transferred into an aqueous solution.

Services also include research into the geology of the sample area and evaluation of relevant geological system within the sampling vicinity.

Geography

The sample site is close to the South Pahroc Mountain Range and the Pahroc designated wilderness area. According to the Wilderness.net's South Pahroc Range Wilderness Fact Sheet, the mountains to the west are extremely rugged with deeply cut canyons, high ridges, large rounded boulders and heavily forested expanses ranging from 5,000 to 7,950 feet. The range itself is a solitary volcanic massif composed of varying colored layers of welded tuff that have weathered into unusual pockets, columns and stone faces. Lower elevations are gently rolling bajadas with scattered volcanic tuff boulders. Several pinnacle outcrops, including the sample location, are comprised of the same rock type sticking through the alluvial cover.

The mountain range creates an 'island in the sky' effect. Moderately deep, steep-walled drainages cut across the mountain from east to west. Differential weathering of the volcanic welded tuff layers has created numerous pockets, holes, columns and the ubiquitous, large rounded boulders, some of which are scattered through the valley to the East. The rocky geologic features are interlaced with stands of pinyon-juniper, white fir and aspen, forming isolated glades.

Physical Test Results:

Mohs Hardness: ~ 6

Specific Gravity:
Single Pan Hydrostatic Method: 2.38 g/cm^3 ± 0.01 g/cm^3 *Precision:* 99.04%
Common density range of rhyolite volcanic rock is 2.35 g/cm^3 - 2.70 g/cm^3

Color: tan brown (fresh); darker brown (weathered)

Cleavage: No rock cleavage observed

Streak: N/A - rock sample, not a mineral

Luster: N/A - rock sample, not a mineral

Magnetism:
Magnetometer Reading: ~40µT; equal to background or earth's magnetic field

Effervescence: None, except on weathered calcareous surfaces

Tenacity: N/A - rock sample, not a mineral

Radioactivity:
Radioactivity Reading: roughly 45 cpm; indicative of natural background radiation

Diaphaneity: N/A - rock sample, not a mineral

Organoleptic assessment: No particular taste or smell associated with the sample

Response to UV radiation:
Shortwave (254 nm): rock none; cream brown fluorescence for calcareous coatings
Longwave (365 nm): rock none; strong pink-orange fluorescence for calcareous coatings, common for the mineral calcite

Wet Geochemical Instrumental Analysis:

Whole rock geochemistry of the sample was processed through ALS USA Inc. After digestion of a powdered sample split and transference into an acidic aqueous solution, the analysis of the digest was performed using ICP-AES (Inductively Coupled Plasma Atomic Emission Spectroscopy). Here, the chemical elements are excited in a plasma flame, and emit certain spectra indicative and quantifiable for each element in the periodic table. Therefore, a multitude of chemical elements can be measured simultaneously with great sensitivity. In addition, Loss-on-Ignition (LOI) on the sample was executed via 1,000°C furnace. Before and after weight measurements indicate volatile materials present in the sample. Results of the analysis are reported in the table below:

Results from ALS USA Inc. reported as percent oxides:

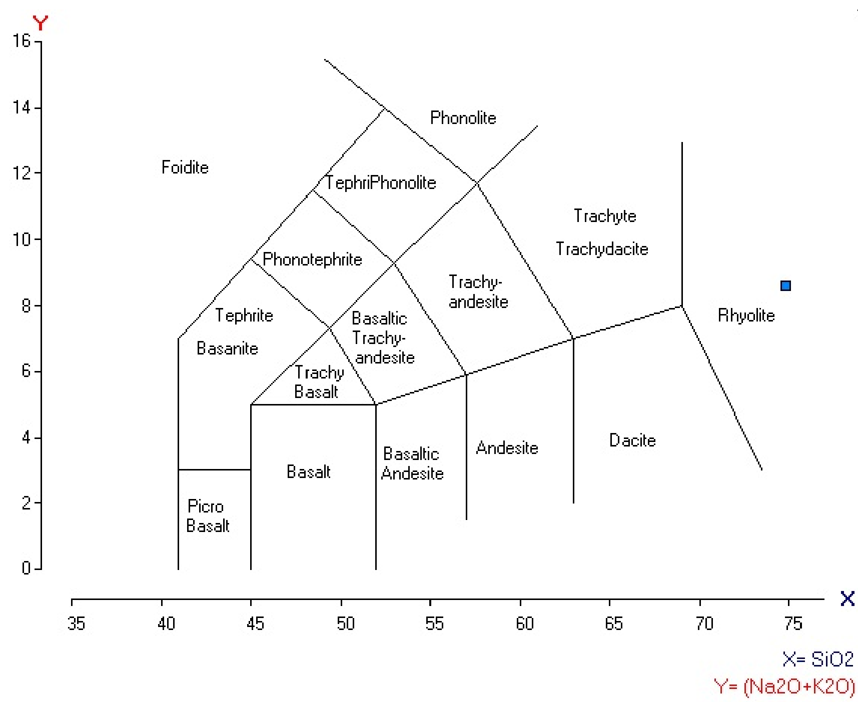
	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	Cr_2O_3	TiO_2	MnO	P_2O_5	SrO	BaO	LOI
%	73.2	11.3	2.85	1.31	0.49	4.01	4.37	<0.002	0.2	0.06	0.02	<0.01	0.02	1.69

Calculated equivalent elemental concentrations:

	Si	Al	Fe	Ca	Mg	Na	K	Cr	Ti	Mn	P	Sr	Ba	
%	34.214	5.98	1.99	0.94	0.3	2.97	3.63	0	0.12	0	0	0	0	
	Si	Al	Fe	Ca	Mg	Na	K	Cr	Ti	Mn	P	Sr	Ba	
ppm	3.42e+05	5.98e+04	1.99e+04	9.36e+03	2.95e+03	2.97e+04	3.63e+04	13.7	1199	465	87.3	84.6	179	

ppm = parts per million or mg/kg

Data interpretation / comments:



The high silica content coupled with elevated potassium and sodium values and low chromium and magnesium points to a felsic (acidic), volcanic rock of terrestrial origin. This is further validated when using a TAS classification as pictured, showing a definite rhyolite, a common terrestrial igneous rock substantiated by the known geology of the Pahroc valley.

Extraterrestrial material would have highly elevated chromium, iron and magnesium values with a very low silica content. The physical sample texture would also be much different, with a well developed crust and absence of vesicles.

The low LOI (Loss-on-Ignition) value of only 1.68% indicates lack of altered clays, carbonate minerals, and hydrated minerals within the submitted sample.

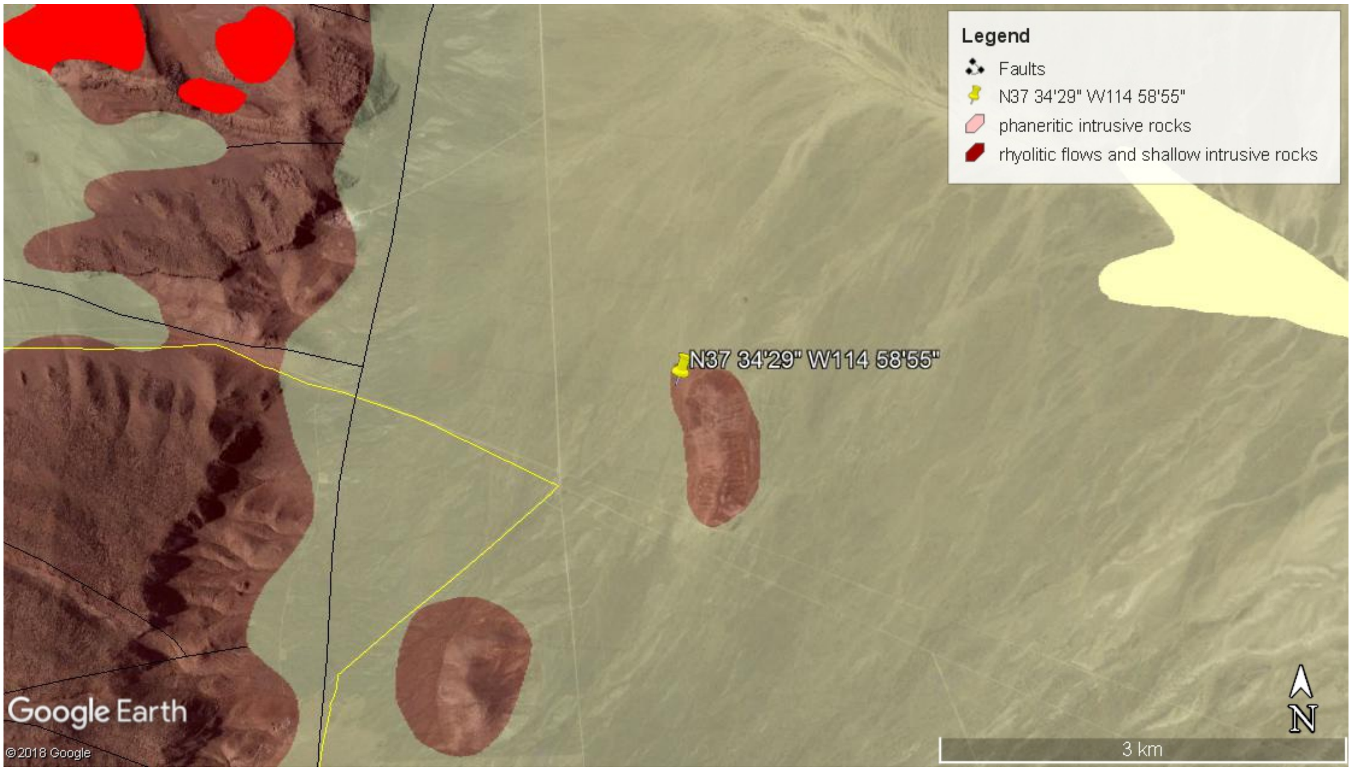
The mineral composition of the submitted sample can be estimated through a process called "Normative Calculations". Igneous minerals follow a predictable pattern of formation governed by chemical laws and equilibria. Thus a process called CIPW (Cross, Iddings, Pirsson and Washington) normative mineral calculation can be employed to produce an idealized mineralogy of a fine grained igneous rock, where individual mineral crystals are too small to identify. The normative calculation from the geochemical analysis of the submitted sample yields the following idealized mineralogical composition:

Normative Minerals	Weight % Norm	Volume % Norm
Quartz	38.17	38.57
Plagioclase	25.83	26.40
Orthoclase	25.88	27.08
Nepheline		
Leucite		
Kalsilite		
Corundum	1.57	1.05
Diopside		
Hypersthene	1.22	1.02
Wollastonite		
Olivine		
Larnite		
Acmite		
K2SiO3		
Na2SiO3		
Rutile	0.20	0.13
Ilmenite		
Magnetite		
Hematite	2.86	1.46
Apatite	0.05	0.04
Zircon		
Perovskite		
Chromite		
Sphene		
Pyrite	0.42	0.23
Halite		
Fluorite		
Anhydrite		
Na2SO4		
Calcite	2.30	2.28
Na2CO3	1.65	1.75

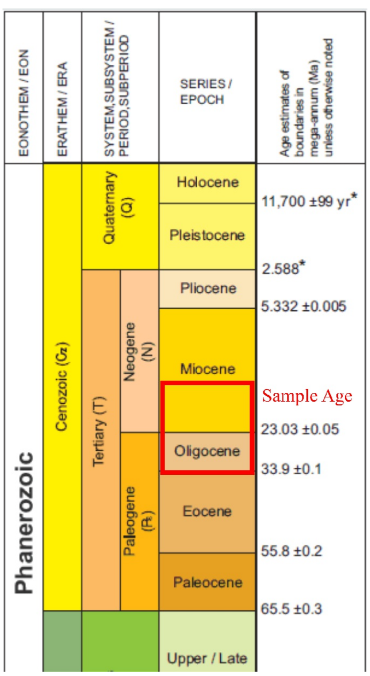
Quartz, plagioclase, and orthoclase are the most common minerals on the surface of the earth and are associated with felsic (acidic) igneous rocks, indicating a definite terrestrial origin. Extraterrestrial materials would show olivine, diopside, magnetite, chromite in large quantities, which are not indicated in the calculation results for the mineralogy of the submitted sample.

The Geology of the Sample and Vicinity

The sample area shows “Intermediate silicic ash flow tuff”, a volcanic rock of violent origin, mapped as unit Tt2 on Nevada’s geologic map (see brown areas in the depicted map below). This rock unit is felsic-volcanic and contains pyroclastic-ash flows and pyroclastic-air fall units. Welded and nonwelded silicic ash flow tuffs cover more of Nevada than any other rock, aside from alluvial covers, and crop out in every Nevada county except Clark. Locally minor beds of tuffaceous air fall tuff occur within Tt2 mingled with sedimentary and metamorphosed Paleozoic units.



Geologic map of the sample location and vicinity. Brown indicates the Tt2 volcanic tuffs and rhyolites, red are phaneritic (coarse grained) intrusive igneous rocks, and the vast grey-green area shows the extensive alluvial cover of the Pahroc Valley. The light yellow area in the northeastern section of the depicted map indicates younger fluvial or river deposited sediment.



Rhyolitic tuffs point to volcanic pyroclastic flows indicative of very violent eruptions. These are caused by exploding volcanoes and can cover vast areas in hot, dense material as it rains from the sky or moves at hurricane speeds down a volcanic mountain side. Similar events have buried the ancient city of Pompeii in Italy and killed another 300 people in Herculaneum during the famous 79 AD eruption of Vesuvius. Welded tuffs occur when erupted volcanic particulates are hot and molten enough, that they start to stick or weld together as they settle to the ground.

These violent eruptions happened in Nevada during the lower Miocene and Oligocene epochs, about 20 to 40 million years ago as indicated in the time scale figure. The submitted sample was likely formed during this time period as this area was very volcanically active in the distant past.

Some of these rhyolitic volcanic rocks in the South Pahroc range contain pockets of perlite, an amorphous volcanic glass with high water content which is mined for valuable industrial applications such as lightweight plasters, concrete and mortar (masonry), insulation and ceiling tiles. Interestingly, perlite has a very similar geochemical composition as the sample analyzed for this report.

A 1988 study by the USGS (United States Geological Survey) of the South Pahroc area west of the sampling site shows a strongly magnetized anomaly near the southern boundary, most likely produced by magnetized hypabyssal intrusions below the surface.

Anomalous concentrations of gold associated with elevated values for arsenic, mercury, antimony, thallium, and tungsten have been discovered in the South Pahroc Mountains. These deposits are often highly silicified, are associated with fracture systems, or are present at contacts with overlying volcanic rocks.

Conclusion

The submitted sample is a felsic rhyolitic fine grained volcanic rock that is common to the sampling area. Rock chemistry and low specific gravity verify a definite terrestrial origin. The rock sample originated sometime between 20 to 40 million years ago from violent volcanic eruptions, forming large layers of resilient rhyolitic tuffs, common throughout Nevada. The geochemical composition of the submitted sample is very similar to perlite deposits mined in close vicinity to the collection site.

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