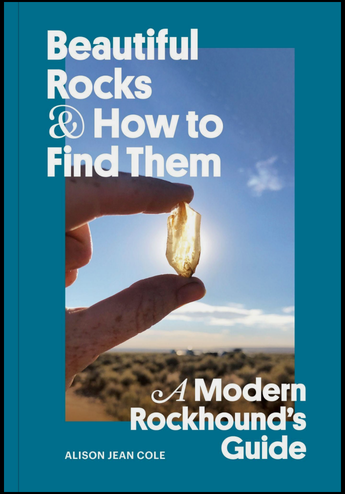
Tracing Geological History Through Rocks & Minerals In Oregon's High Desert

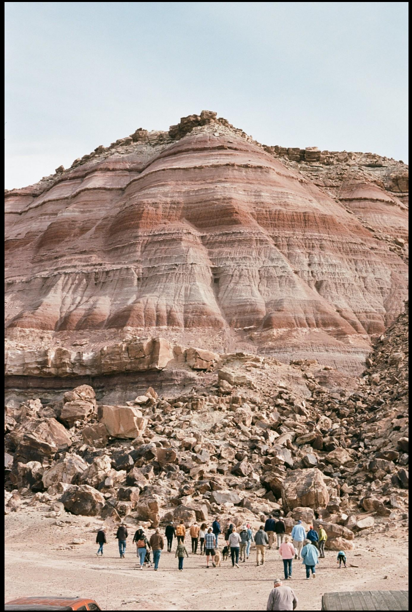
with Alison Jean Cole

“the mute word of the Earth”

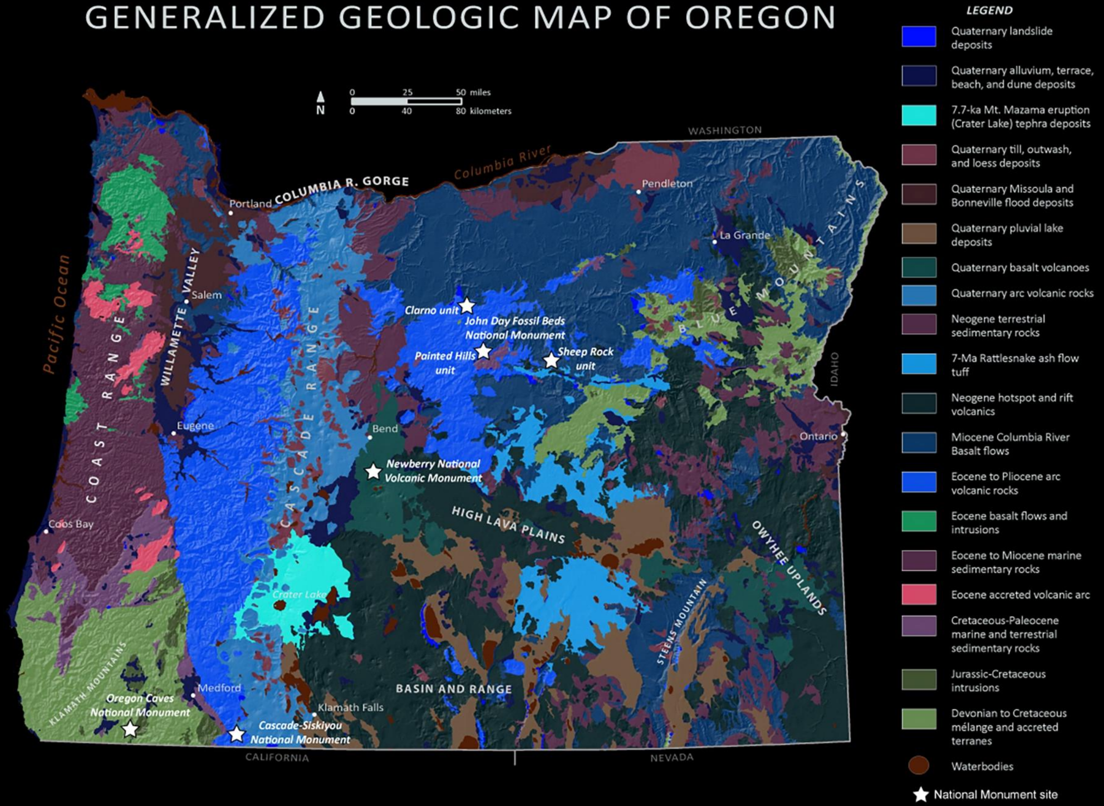
Rocks: my world revolves around them



GREEN RIVER
ROCKS
20 24



GENERALIZED GEOLOGIC MAP OF OREGON



Source: DOGAMI


Let us enter their world

OBSIDIAN

“the psychic mirror”

An amorphous glass burped up in eruptions

Obsidian was likely the most distantly-traded material in the paleolithic world.

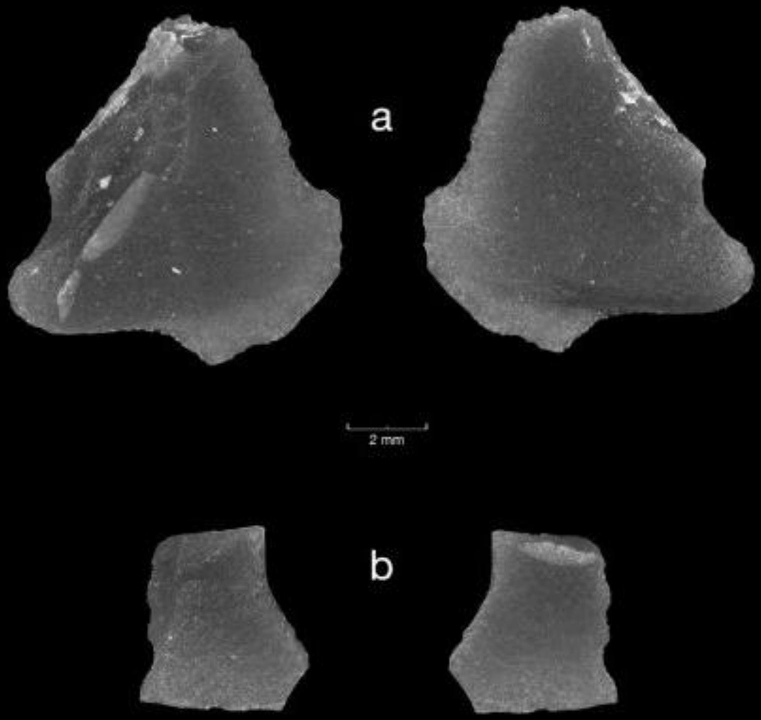
Obsidian was likely the most distantly-traded material in the paleolithic world.

Nothing makes a finer tool, even to this day.

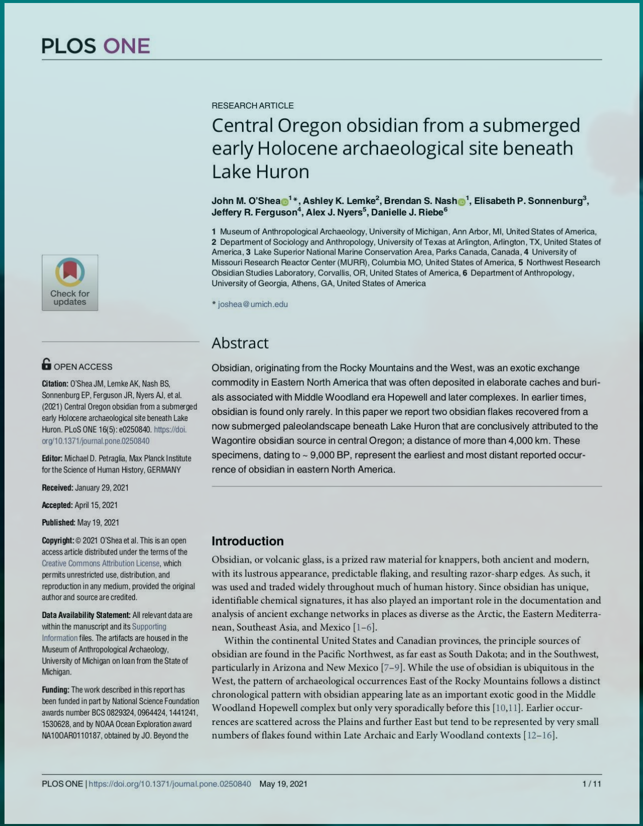
Elizabethan scrying mirror, circa 1580's, England.

Elizabethan scrying mirror, circa 1580's, England.

The obsidian disc within hails from Pachuca, Mexico, almost 9,000km away.



The oldest of travelers



PLOS ONE

RESEARCH ARTICLE

Central Oregon obsidian from a submerged early Holocene archaeological site beneath Lake Huron

John M. O'Shea[1]*, Ashley K. Lemke[2], Brendan S. Nash[1], Elisabeth P. Sonnenburg[3], Jeffery R. Ferguson[4], Alex J. Nyers[5], Danielle J. Riebe[6]

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OPEN ACCESS

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Abstract

Obsidian, originating from the Rocky Mountains and the West, was an exotic exchange commodity in Eastern North America that was often deposited in elaborate caches and burials associated with Middle Woodland era Hopewell and later complexes. In earlier times, obsidian is found only rarely. In this paper we report two obsidian flakes recovered from a now submerged paleolandscape beneath Lake Huron that are conclusively attributed to the Wagontire obsidian source in central Oregon; a distance of more than 4,000 km. These specimens, dating to ~ 9,000 BP, represent the earliest and most distant reported occurrence of obsidian in eastern North America.

Introduction

Obsidian, or volcanic glass, is a prized raw material for knappers, both ancient and modern, with its lustrous appearance, predictable flaking, and resulting razor-sharp edges. As such, it was used and traded widely throughout much of human history. Since obsidian has unique, identifiable chemical signatures, it has also played an important role in the documentation and analysis of ancient exchange networks in places as diverse as the Arctic, the Eastern Mediterranean, Southeast Asia, and Mexico [1–6].

Within the continental United States and Canadian provinces, the principle sources of obsidian are found in the Pacific Northwest, as far east as South Dakota; and in the Southwest, particularly in Arizona and New Mexico [7–9]. While the use of obsidian is ubiquitous in the West, the pattern of archaeological occurrences East of the Rocky Mountains follows a distinct chronological pattern with obsidian appearing late as an important exotic good in the Middle Woodland Hopewell complex but only very sporadically before this [10,11]. Earlier occurrences are scattered across the Plains and further East but tend to be represented by very small numbers of flakes found within Late Archaic and Early Woodland contexts [12–16].

A discovery spanning 9,000 years and 4.000 kilometers.

Fig 1. Map of the Lake Huron Basin. Areas shaded green represent the modern coast and land surface; brown areas represent dry land during the Lake Stanley lowstand, and blue represents the location of the lakes at approximately 10,000 yrs BP. Red rectangles represent areas where archaeological research has been conducted. The location of the obsidian finds, sample DA-1, is indicated.

A new world emerges as the ice sheets retreat.

The Earth and her cultures rebound.

“But how do they know???”

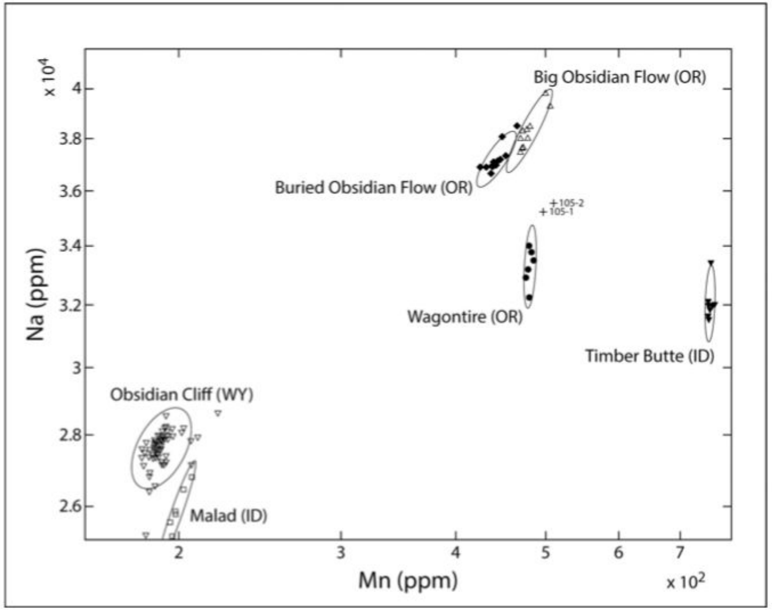
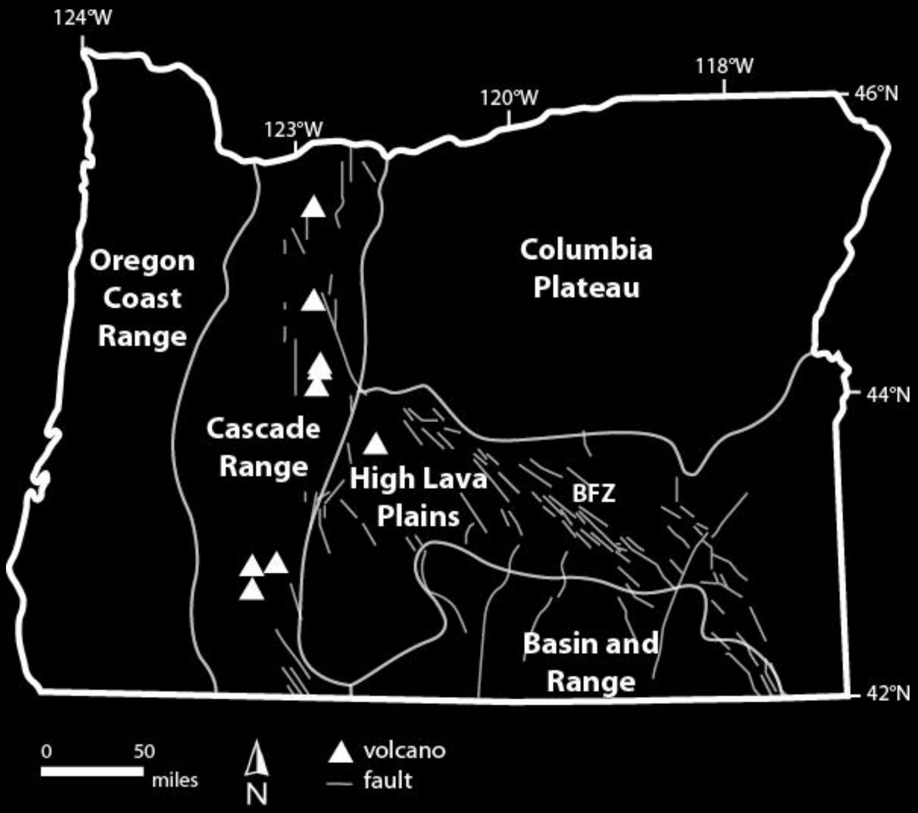


Fig 5. Displays measurement for two elements, sodium and manganese for several commonly utilized obsidian sources as well as the two Lake Huron artifacts. Ellipses represent statistical confidence intervals for geological source materials. It is clear that the Lake Huron artifacts most closely match the geological signature generated for the Wagontire source.

Magic.

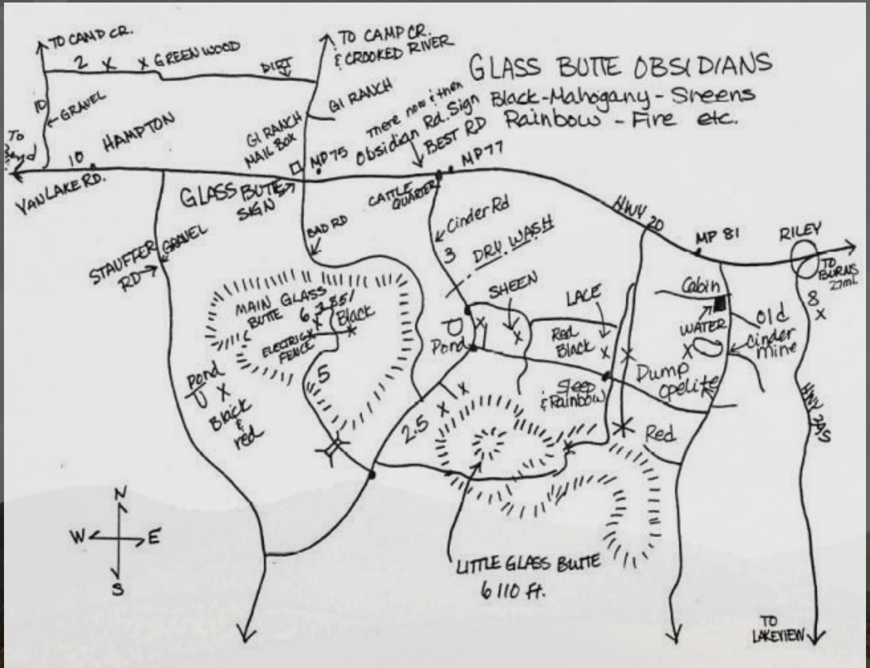
(and chemical languages deciphered by the Northwest Research Obsidian Studies Laboratory)

Central Oregon is *glass country.*



Adapted from Poux, Bastien & Suemnicht, Gene. (2012).


Image courtesy USFS



The famous Glass Buttes map drawn by Highland Rock Shop in Burns

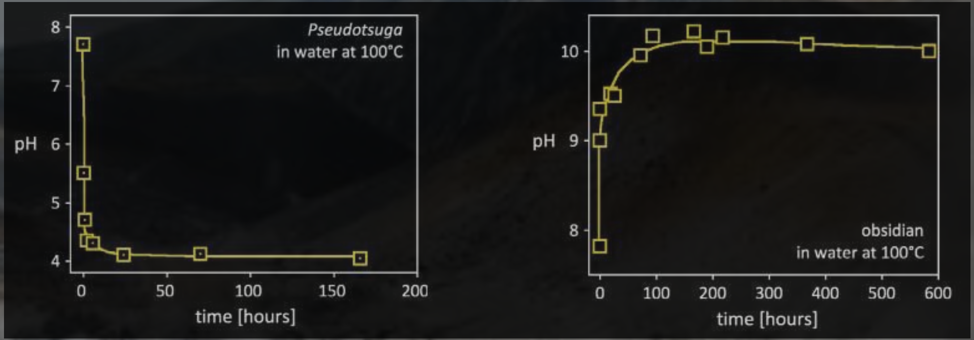
PETRIFIED WOOD

“the stone of transformation”

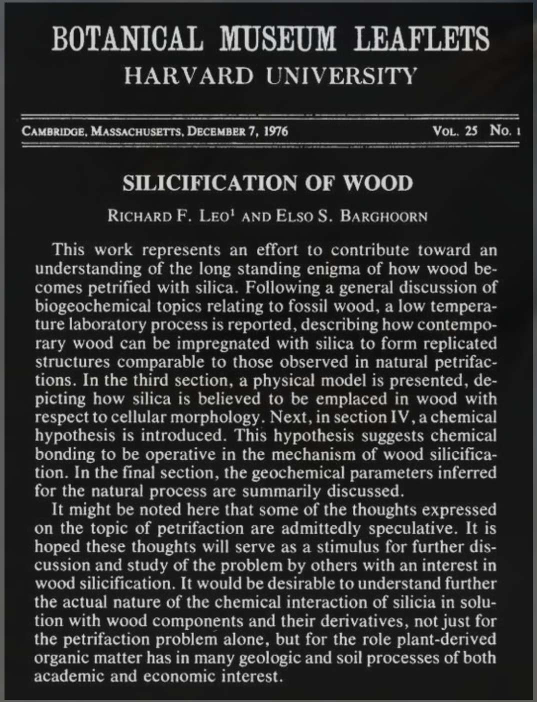
A moment frozen in time

“But how???”

Many have tried to answer the question



Excerpts from Leo & Barghoorn (1976), Akahane, et all (2004), Ballhaus, et al (2012)



BOTANICAL MUSEUM LEAFLETS
HARVARD UNIVERSITY

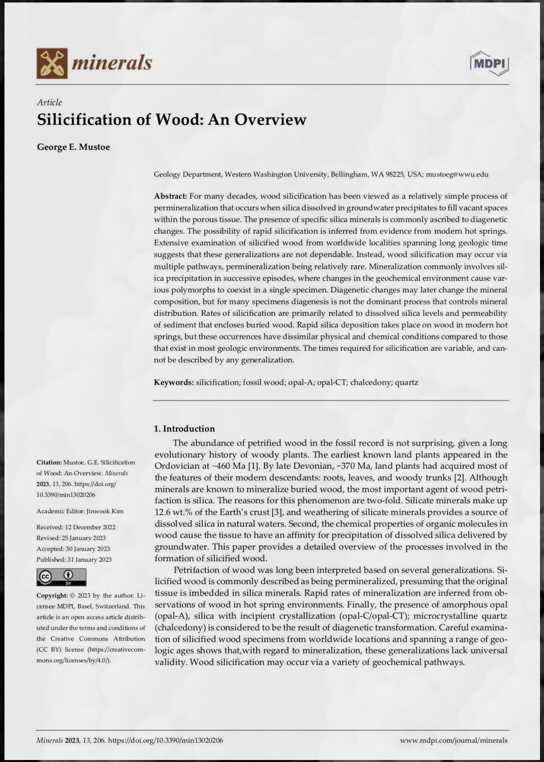
CAMBRIDGE, MASSACHUSETTS, DECEMBER 7, 1976 VOL. 25 NO. 1

SILICIFICATION OF WOOD

RICHARD F. LEO[1] AND ELSO S. BARGHOORN

This work represents an effort to contribute toward an understanding of the long standing enigma of how wood becomes petrified with silica. Following a general discussion of biogeochemical topics relating to fossil wood, a low temperature laboratory process is reported, describing how contemporary wood can be impregnated with silica to form replicated structures comparable to those observed in natural petrifactions. In the third section, a physical model is presented, depicting how silica is believed to be emplaced in wood with respect to cellular morphology. Next, in section IV, a chemical hypothesis is introduced. This hypothesis suggests chemical bonding to be operative in the mechanism of wood silicification. In the final section, the geochemical parameters inferred for the natural process are summarily discussed.

It might be noted here that some of the thoughts expressed on the topic of petrifaction are admittedly speculative. It is hoped these thoughts will serve as a stimulus for further discussion and study of the problem by others with an interest in wood silicification. It would be desirable to understand further the actual nature of the chemical interaction of silicia in solution with wood components and their derivatives, not just for the petrifaction problem alone, but for the role plant-derived organic matter has in many geologic and soil processes of both academic and economic interest.


minerals MDPI

Article

Silicification of Wood: An Overview

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Abstract: For many decades, wood silicification has been viewed as a relatively simple process of permineralization that occurs when silica dissolved in groundwater precipitates to fill vacant spaces within the porous tissue. The presence of specific silica minerals is commonly ascribed to diagenetic changes. The possibility of rapid silicification is inferred from evidence from modern hot springs. Extensive examination of silicified wood from worldwide localities spanning long geologic time suggests that these generalizations are not dependable. Instead, wood silicification may occur via multiple pathways, permineralization being relatively rare. Mineralization commonly involves silica precipitation in successive episodes, where changes in the geochemical environment cause various polymorphs to coexist in a single specimen. Diagenetic changes may later change the mineral composition, but for many specimens diagenesis is not the dominant process that controls mineral distribution. Rates of silicification are primarily related to dissolved silica levels and permeability of sediment that encloses buried wood. Rapid silica deposition takes place on wood in modern hot springs, but these occurrences have dissimilar physical and chemical conditions compared to those that exist in most geologic environments. The times required for silicification are variable, and cannot be described by any generalization.

Keywords: silicification; fossil wood; opal-A; opal-CT; chalcedony; quartz

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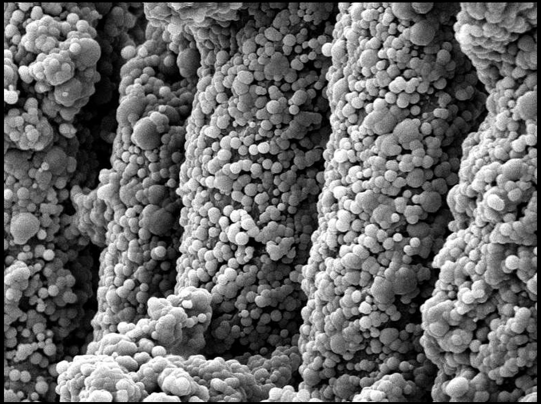
1. Introduction

The abundance of petrified wood in the fossil record is not surprising, given a long evolutionary history of woody plants. The earliest known land plants appeared in the Ordovician at ~460 Ma [1]. By late Devonian, ~370 Ma, land plants had acquired most of the features of their modern descendants: roots, leaves, and woody trunks [2]. Although minerals are known to mineralize buried wood, the most important agent of wood petrifaction is silica. The reasons for this phenomenon are two-fold. Silicate minerals make up 12.6 wt.% of the Earth's crust [3], and weathering of silicate minerals provides a source of dissolved silica in natural waters. Second, the chemical properties of organic molecules in wood cause the tissue to have an affinity for precipitation of dissolved silica delivered by groundwater. This paper provides a detailed overview of the processes involved in the formation of silicified wood.

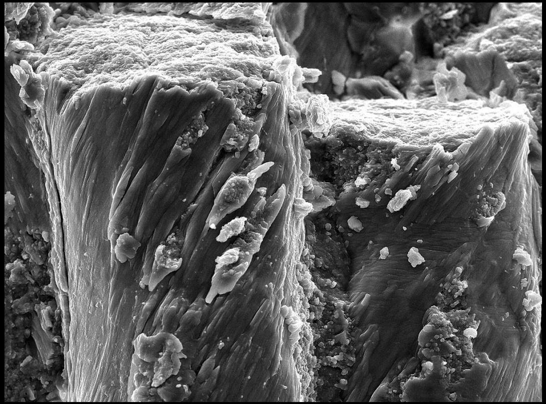
Petrifaction of wood was long been interpreted based on several generalizations. Silicified wood is commonly described as being permineralized, presuming that the original tissue is imbedded in silica minerals. Rapid rates of mineralization are inferred from observations of wood in hot spring environments. Finally, the presence of amorphous opal (opal-A), silica with incipient crystallization (opal-C/opal-CT); microcrystalline quartz (chalcedony) is considered to be the result of diagenetic transformation. Careful examination of silicified wood specimens from worldwide locations and spanning a range of geologic ages shows that,with regard to mineralization, these generalizations lack universal validity. Wood silicification may occur via a variety of geochemical pathways.

Enter George Mustoe, wizard of petrified wood

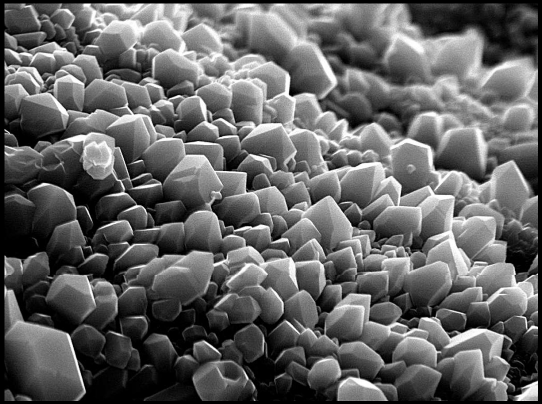
The Silica Sisters



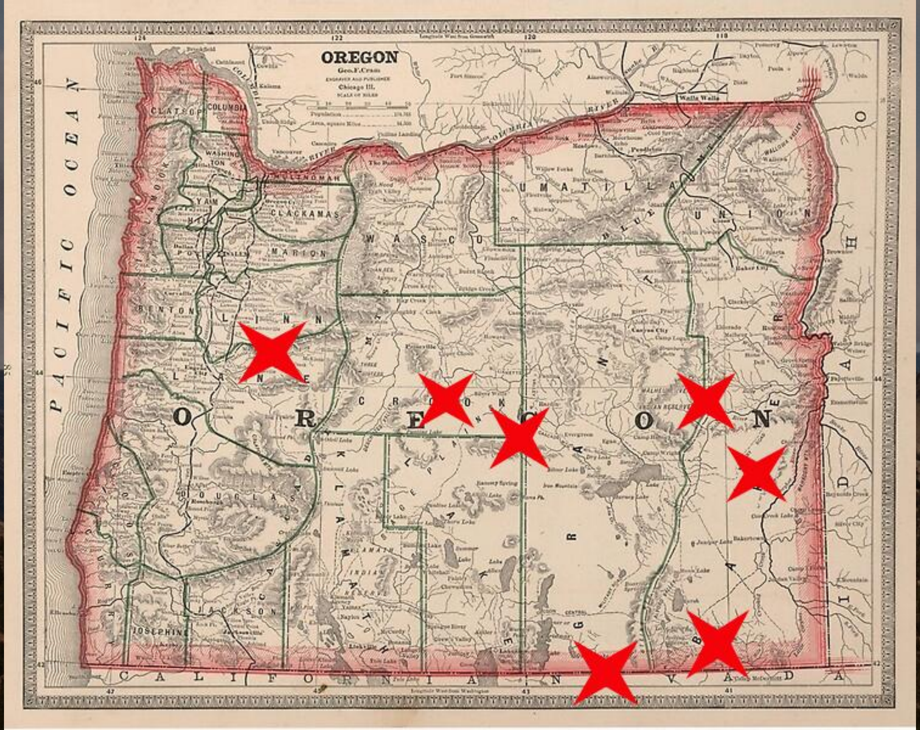
Opal



Chalcedony



Quartz



Petrified forests of Oregon

“Petrified wood reinforces the idea that a rock can be a living thing, and that a living thing can be a rock, that energy and matter can pass back and forth across the veil.”

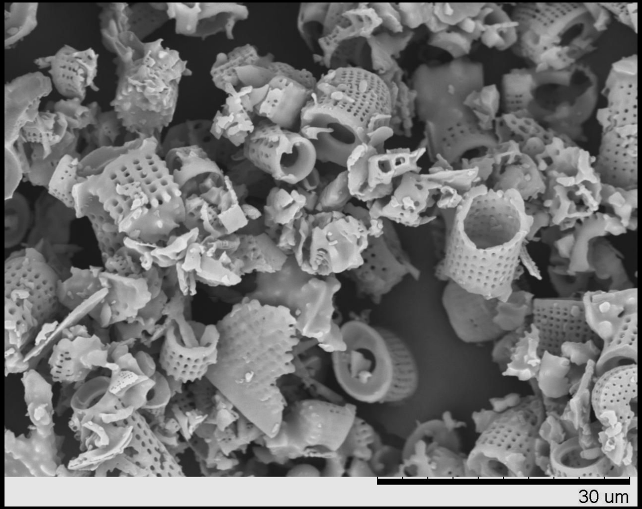
—Martin Holden

..Soft tissue replaced by stone
particle by particle
carried across space and time
tumbling from the wounds
until massive shards resurface
fossilized
into a jewel
that is also a clock
that is also an archive
that is also a grave.

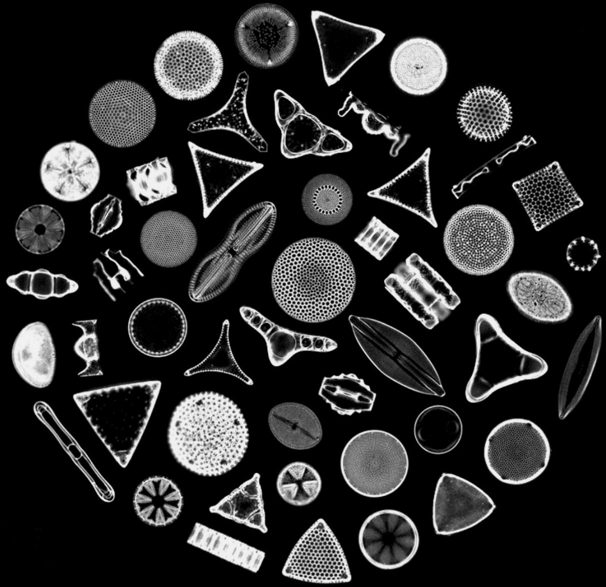
—Helen Shewolfe Tseng

“But what about the leaves??”

The stuff of lakes long-gone



Photomicrograph courtesy Dawid Siodlak



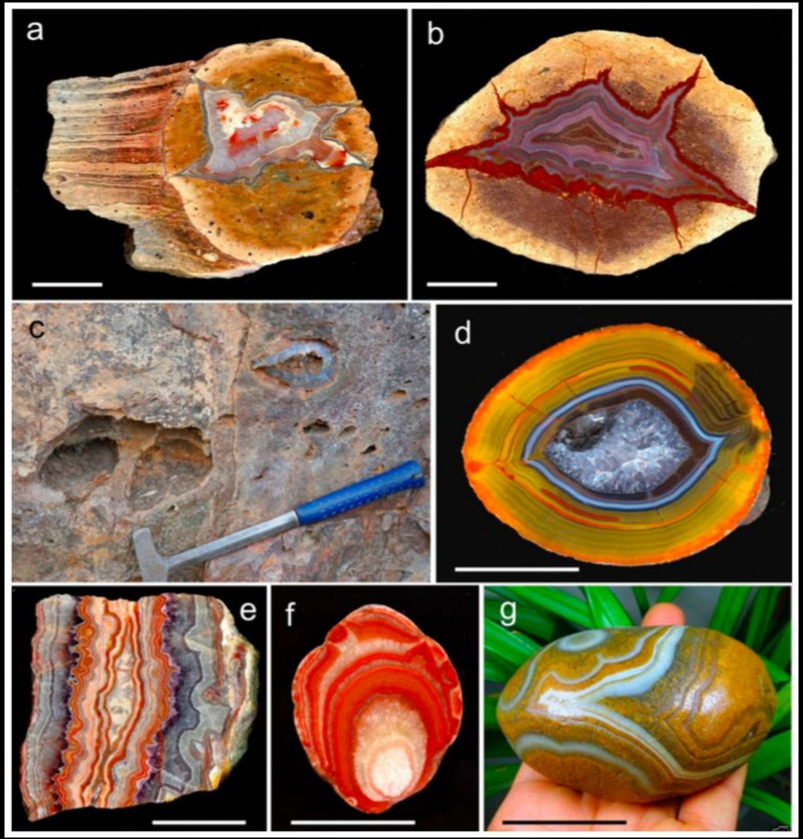
Photomicrograph courtesy Randolph Femmer

THE SILICATES

"stones of endurance"

The stuff of volcanoes

Agates: treasures of the void



Mineralogy, Geochemistry and Genesis of Agate—A Review. Götze, *et al* (2020)

minerals

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Review

Mineralogy, Geochemistry and Genesis of Agate—A Review

Jens Götze [1,*], Robert Möckel [2] and Yuanming Pan [3]

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3 Department of Geological Sciences, University of Saskatchewan, Saskatoon, SK S7N 5E2, Canada; yuanming.pan@usask.ca
* Correspondence: jens.goetze@mineral.tu-freiberg.de; Tel.: +49-3731-39-2638

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Abstract: Agate—a spectacular form of SiO_2 and a famous gemstone—is commonly characterized as banded chalcedony. In detail, chalcedony layers in agates can be intergrown or intercalated with macrocrystalline quartz, quartzine, opal-A, opal-CT, cristobalite and/or moganite. In addition, agates often contain considerable amounts of mineral inclusions and water as both interstitial molecular H_2O and silanol groups. Most agate occurrences worldwide are related to SiO_2-rich (rhyolites, rhyodacites) and SiO_2-poor (andesites, basalts) volcanic rocks, but can also be formed as hydrothermal vein varieties or as silica accumulation during diagenesis in sedimentary rocks. It is assumed that the supply of silica for agate formation is often associated with late- or post-volcanic alteration of the volcanic host rocks. Evidence can be found in association with typical secondary minerals such as clay minerals, zeolites or iron oxides/hydroxides, frequent pseudomorphs (e.g., after carbonates or sulfates) as well as the chemical composition of the agates. For instance, elements of the volcanic rock matrix (Al, Ca, Fe, Na, K) are enriched, but extraordinary high contents of Ge (>90 ppm), B (>40 ppm) and U (>20 ppm) have also been detected. Calculations based on fluid inclusion and oxygen isotope studies point to a range between 20 and 230 °C for agate formation temperatures. The accumulation and condensation of silicic acid result in the formation of silica sols and proposed amorphous silica as precursors for the development of the typical agate micro-structure. The process of crystallisation often starts with spherulitic growth of chalcedony continuing into chalcedony fibers. High concentrations of lattice defects (oxygen and silicon vacancies, silanol groups) detected by cathodoluminescence (CL) and electron paramagnetic resonance (EPR) spectroscopy indicate a rapid crystallisation via an amorphous silica precursor under non-equilibrium conditions. It is assumed that the formation of the typical agate microstructure is governed by processes of self-organization. The resulting differences in crystallite size, porosity, kind of silica phase and incorporated color pigments finally cause the characteristic agate banding and colors.

Keywords: agate; quartz; chalcedony; silica minerals; micro-structure; trace elements; O-isotopes; paragenetic minerals

1. Introduction

Agates belong to the most fascinating mineral objects in nature because of their wide spectrum of colors and spectacular morphologies. Therefore, they play a dominant role as gemstones and cut stone since antiquity. The name "*Agate*" can be dated back to ca. 350 B.C. (Theophrast) and was probably related to the discovery of agates in the river *Achates* (recently *Drillo*) in Sicily. Today, agate deposits and agate treatments are known from historical and recent sites all over the world [1–4].

Silicate treasures form
after the fact
when the molten rock
around them has frozen.

Enigmatic tuffs

Photo: Kirsten Southwell

Accumulation during diagenesis

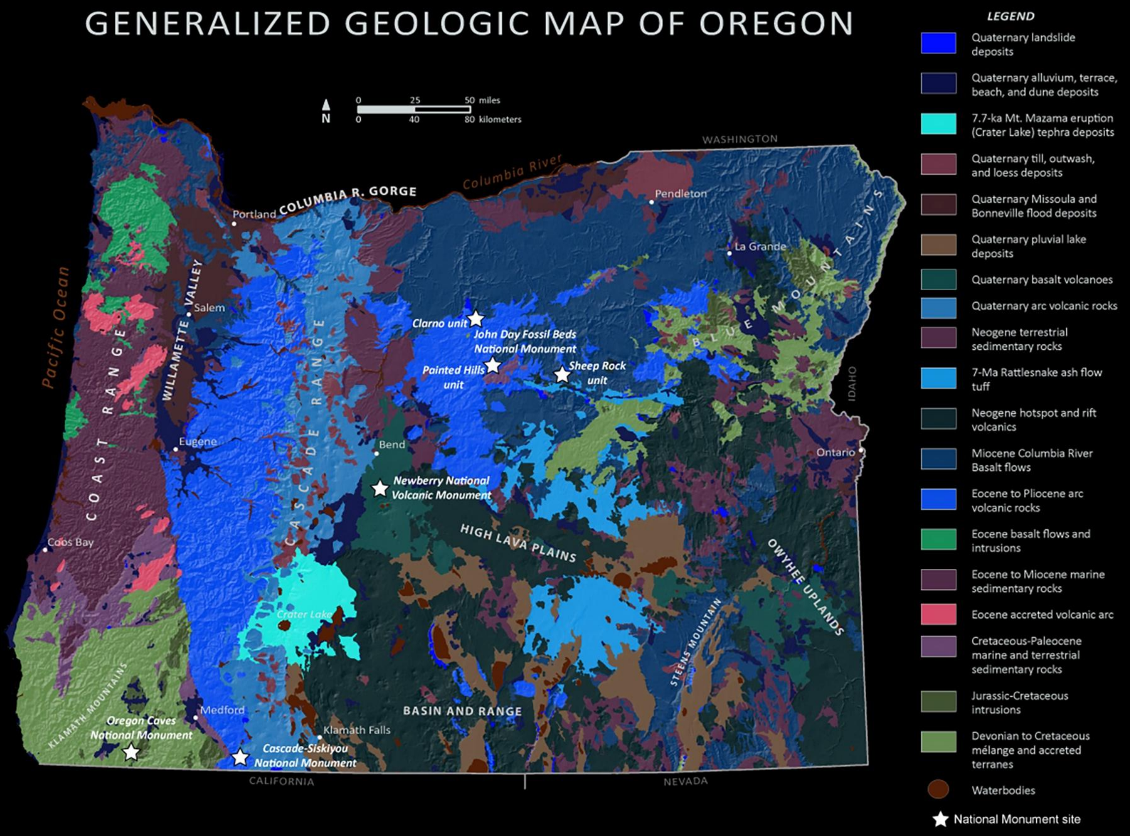
"But what about crystals??"

The mighty sunstone

Elusive calcite

“But what lies beneath?”

GENERALIZED GEOLOGIC MAP OF OREGON



Source: DOGAMI

ROCKHOUNDS

"the untapped ally"

We are desert denizens

We know these places inside out and yearn to see them protected.

Rockhounds are the first group excluded when public lands are developed for mining.

There are 15 official rock clubs in Oregon, plus several informal clubs and online groups.

Rock clubs usually have a few hundred members. There are many thousand of us in Oregon.

A novel idea..


8 cm
rectification targets 50mm x 20mm
red yellow green blue

"Rocks are reminders that history, wonder,
beauty, and surprise are everywhere,
all around us, all the time"

–Nora Bauman


Alison Jean Cole
@alisonjeancole

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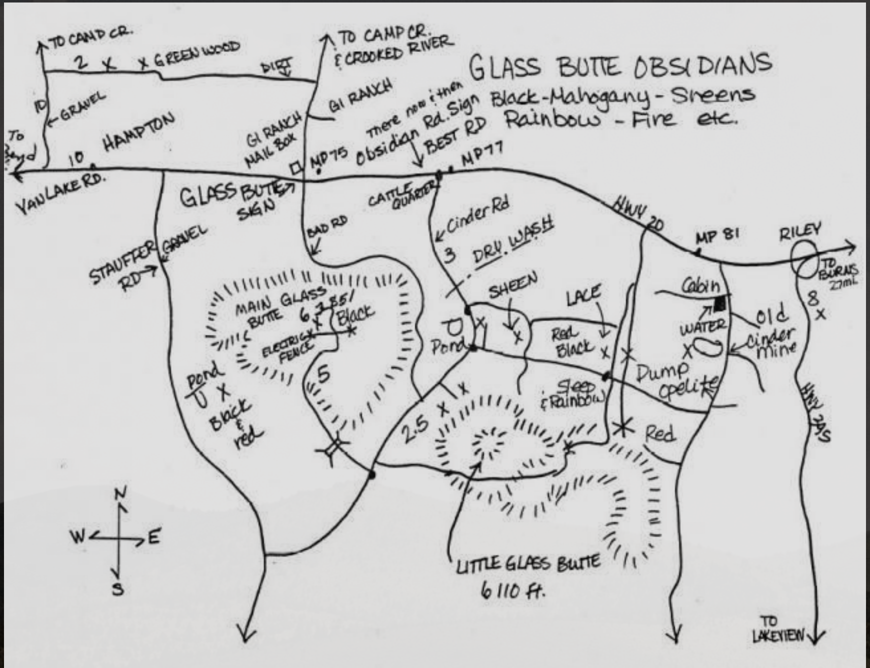

GLASS BUTTE OBSIDIANS
Black-Mahogany - Sheens
Rainbow - Fire etc.
TO CAMP CR.
TO CAMP CR. & CROOKED RIVER
GREEN WOOD
DIRT
GRAVEL
GI RANCH
GI RANCH MAIL BOX
HAMPTON
VAN LAKE RD.
MP 75
There now & then Obsidian Rd. Sign
BEST RD
MP 77
GLASS BUTTE SIGN
CATTLE QUARTER
BAD RD
Cinder Rd
DRY WASH
HWY 20
MP 81
RILEY
TO BURNS
STAUFFER RD
MAIN GLASS BUTTE
Black
ELECTRIC FENCE
SHEEN
LACE
Cabin
WATER
Old Cinder Mine
Pond
Red Black
Dump
Sheen & Rainbow
Red
Black & red
HWY 395
LITTLE GLASS BUTTE
6110 ft.
TO LAKEVIEW
N
W
E
S

minerals
MDPI

Article

Silicification of Wood: An Overview

George E. Mustoe

Geology Department, Western Washington University, Bellingham, WA 98225, USA; mustoeg@wwu.edu

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minerals

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Review

Mineralogy, Geochemistry and Genesis of Agate—A Review

Jens Götze [1,*], Robert Möckel [2] and Yuanming Pan [3]

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Abstract: Agate—a spectacular form of SiO_2 and a famous gemstone—is commonly characterized as banded chalcedony. In detail, chalcedony layers in agates can be intergrown or intercalated with macrocrystalline quartz, quartzine, opal-A, opal-CT, cristobalite and/or moganite. In addition, agates often contain considerable amounts of mineral inclusions and water as both interstitial molecular H_2O and silanol groups. Most agate occurrences worldwide are related to SiO_2-rich (rhyolites, rhyodacites) and SiO_2-poor (andesites, basalts) volcanic rocks, but can also be formed as hydrothermal vein varieties or as silica accumulation during diagenesis in sedimentary rocks. It is assumed that the supply of silica for agate formation is often associated with late- or post-volcanic alteration of the volcanic host rocks. Evidence can be found in association with typical secondary minerals such as clay minerals, zeolites or iron oxides/hydroxides, frequent pseudomorphs (e.g., after carbonates or sulfates) as well as the chemical composition of the agates. For instance, elements of the volcanic rock matrix (Al, Ca, Fe, Na, K) are enriched, but extraordinary high contents of Ge (>90 ppm), B (>40 ppm) and U (>20 ppm) have also been detected. Calculations based on fluid inclusion and oxygen isotope studies point to a range between 20 and 230 °C for agate formation temperatures. The accumulation and condensation of silicic acid result in the formation of silica sols and proposed amorphous silica as precursors for the development of the typical agate micro-structure. The process of crystallisation often starts with spherulitic growth of chalcedony continuing into chalcedony fibers. High concentrations of lattice defects (oxygen and silicon vacancies, silanol groups) detected by cathodoluminescence (CL) and electron paramagnetic resonance (EPR) spectroscopy indicate a rapid crystallisation via an amorphous silica precursor under non-equilibrium conditions. It is assumed that the formation of the typical agate microstructure is governed by processes of self-organization. The resulting differences in crystallite size, porosity, kind of silica phase and incorporated color pigments finally cause the characteristic agate banding and colors.

Keywords: agate; quartz; chalcedony; silica minerals; micro-structure; trace elements; O-isotopes; paragenetic minerals

1. Introduction

Agates belong to the most fascinating mineral objects in nature because of their wide spectrum of colors and spectacular morphologies. Therefore, they play a dominant role as gemstones and cut stone since antiquity. The name "*Agate*" can be dated back to ca. 350 B.C. (Theophrast) and was probably related to the discovery of agates in the river *Achates* (recently *Drillo*) in Sicily. Today, agate deposits and agate treatments are known from historical and recent sites all over the world [1–4].