Carbonate Rock with Encapsulated Petrified Wood in Channel of Skate Creek, WA.

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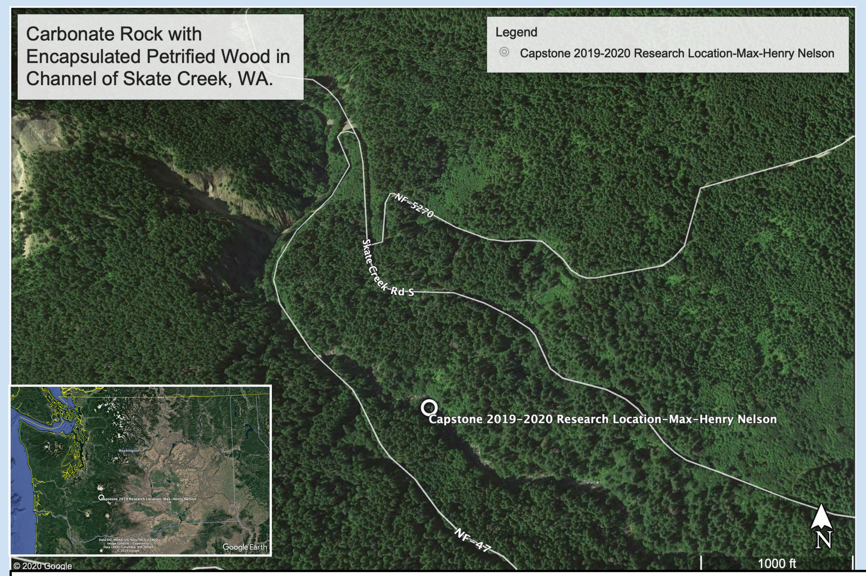
Abstract

Black petrified wood was found in the Skate Creek channel near Packwood Wa within a rock unit that was visually identified as volcaniclastic sediment with carbonate matrix. The most updated USGS unit map does not clearly explain the origin of the petrified wood or the containing rock unit. The goals of the project was to understand: 1) what geological processes and/or event caused petrification of trees within the unit. 2) Why would the petrified wood be completely blackened. 3) How this rock unit compares to existing map units for the area. The methods used were stratigraphic and textural relations observed in the field as well as mineralogical and textural observations made with a petrologic microscope and scanning electron microscope (SEM). Unit was formed in a volcano-clastic mass wasting event that entrained large wood debris. The textural relationship and chemical similarity between the wood and the containing rock suggests that the wood was permineralized within the rock. Bytownite the original volcanic sediments were most likely intermediate - mafic composition. Chlorite and textural relationship with bytownite was found within the containing rock suggesting a metamorphic process up to greenschist facies. Veining texture within the permineralized wood, metamorphic minerals, and an increased bulk composition of $CaCO_3$ suggest possible hydrothermal alteration. USGS map does not correctly identify the lithological unit at this location.



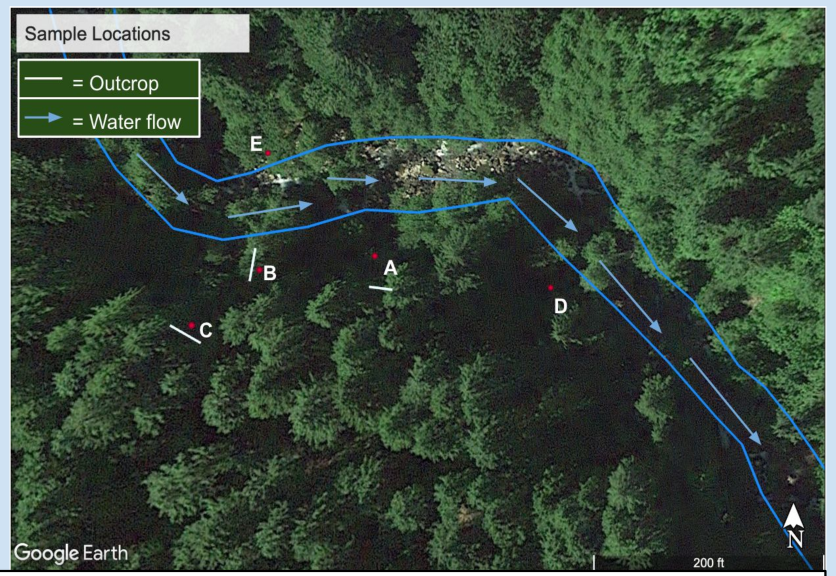


Figure 1 (left): Research location in relation to Wa. Location was identified by overlaying GPS over Google Earth.
Figure 2 (right): Approximate Sample locations(~50ft.)

Background

- Black Petrified wood was found within a rock unit exposed in the Skate Creek channel near Packwood WA. (Figure 1-2)
- Unit appears to be a clastic sediment composed of volcano-clastic fragments.
- Carbonate matrix that does not show clear signs of alteration that could explain the origins of the petrified wood.

Question

What geological processes and/or event caused the burial and partial petrification of trees found within rocks in the Skate Creek channel?

Petrified wood

- Petrified wood is formed by the burial of wood in a large event such as a landslide, pyroclastic flow or ashfall.
- Completely permineralized wood can take thousands of years for calcium carbonate or silicate material to replace the cellular structure of wood leaving almost no original organic material.
- Plant material can be permineralized by varying components however silicate permineralization is significantly more frequent and is better at replacing the cellular structure (Scurfield and Segnit,1983).
- There can be remaining carbon/organic material which can alter the color of the petrified wood leaving it partially blackened (Wood, & Viney, 2014).
- The temperature being less than 100°C is necessary to also not destroy the structure of the wood prior to siliceous cell replacement (Witke et al. 2001).
- After the wood is permineralized there is a "secondary mineralization with calcite and barite in cracks of the former wood"(Witke et al. 2001).

Skate Creek

- Where the sample was taken there was a junction of multiple different units.
- In the channel of upper Skate Creek the unit is mapped as (Tva2) indicating an adicite flow.
- (Tia) is an intrusive andesite.
- (Qls) indicates a geological recent landslide.
- (Tvs3) indicating volcanic sediments from the Miocene.

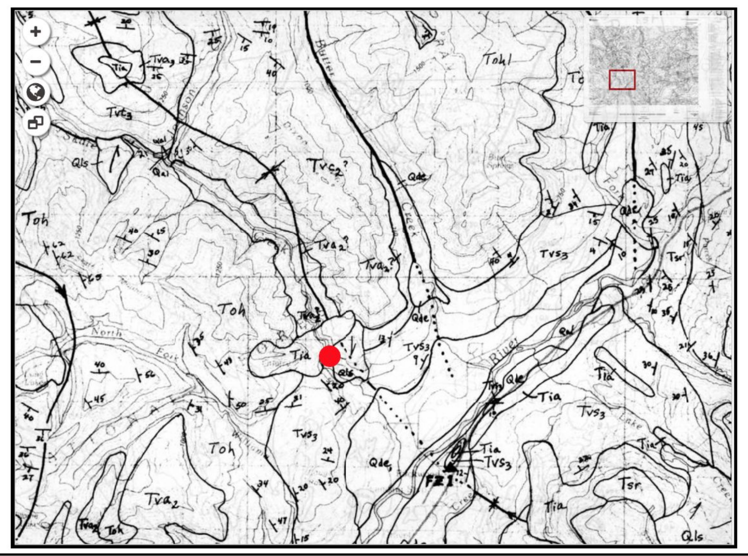


Figure3 : Unit map with red dot as approximate sample site (Schasse,1987)

Methods

Sample Collection

- Field analysis and Hand Samples collection was conducted on 10/5/2019 and 12/1/2019.
- Samples were collected at 5 different locations labeled A-E Figure 1-2).
- 3 sample locations (A-C) were from outcrops of the exposed unit.

Sample Analysis

- Wood -Scratch test on metal for hardness.
- Naming samples (MH,"1 or 2", "location","sample number","number of thin section made").
- 9 thin sections were created for 4 locations (A,B,D,E)(Figure 4).
- Plagioclase was the identifiable mineral used to achieve the correct thickness.
- Location C and upper B unit were visually identified in relation to samples already made.
- A Petrographic microscope was used to identify minerals within thin sections.

SEM Imaging

- 2 samples were selected to be further analysed by Scanning electron microscope.
- One sample was of the petrified wood and the other was of the encapsulating rock.
- Thin sections were polished and coated with carbon using a carbon coater.
- While looking at the monitor, the changes in mineralogy was represented by fluctuation in grey.
- Locations were picked based on this change and the chemical signature was given for those specific locations.
- Mineral identification was then based on the relation of elements. (Severin, 2014)

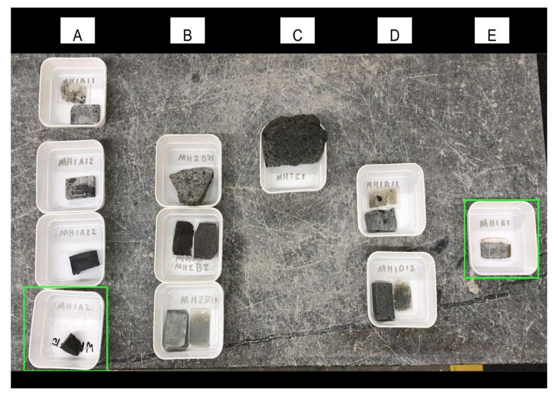


Figure 4: Samples that were used for comparative and thin-section analysis. Sample location from the column header relates to figure 2 locations. Green boxes indicate samples that were used for SEM.

Data

Field

- Two lithological units that show a tilting with the general dip direction being North Figure 7-8).
- Both units have wood embedded and $CaCO_3$ matrix Figure 6-8).
- Upper unit has a higher percentage of $CaCO_3$ and less mud (Figure 7-8).
- Wood texture suggests that it was embedded prior to permineralization (figure 6).

Figure 5 (left): Petrified wood with vein of calcite. Location E (figure 2).
Figure 6 (right): Petrified wood embedded in rock. Location D (figure 2)

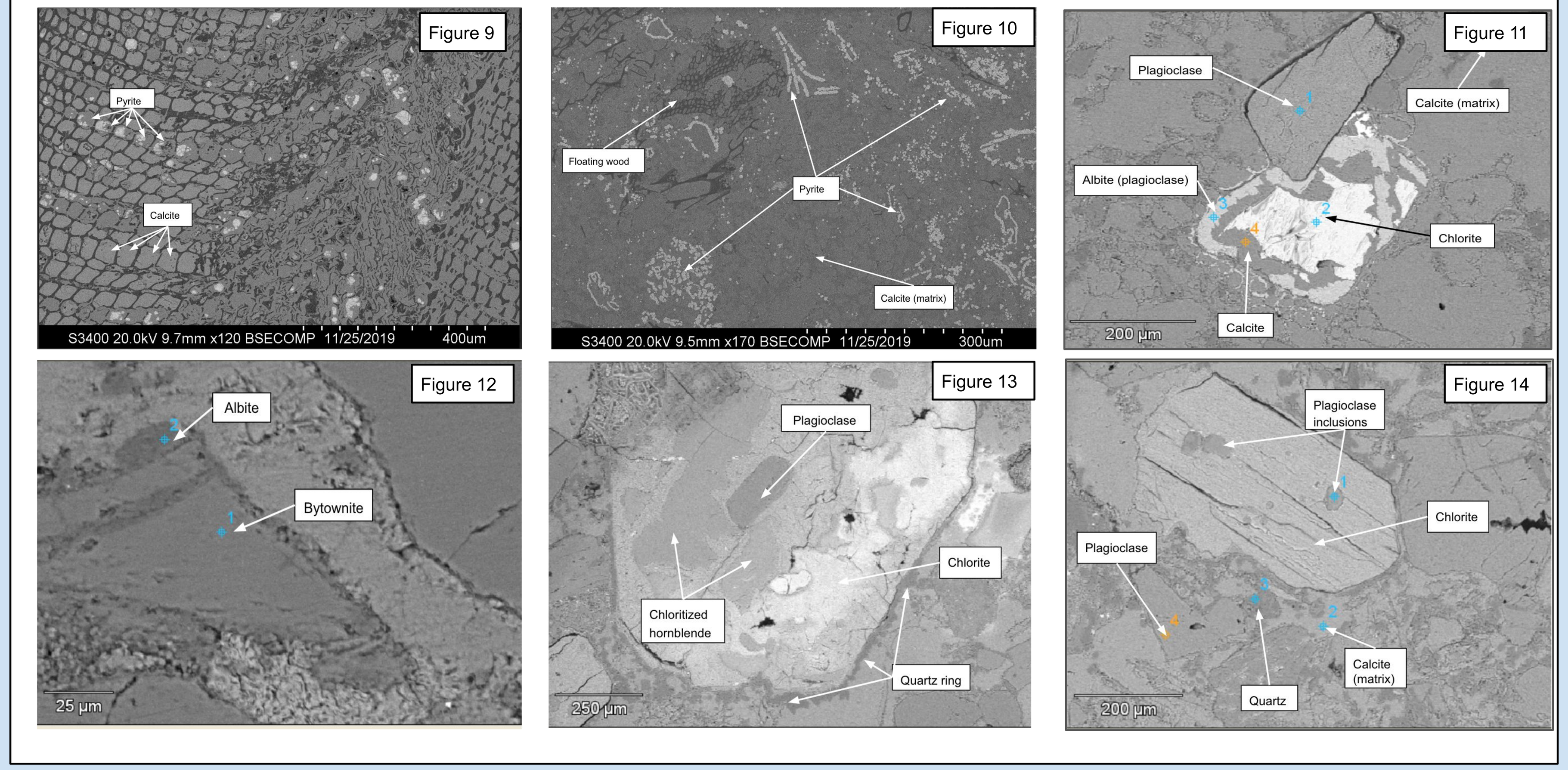
Lab

- Majority of cells were filled in by calcite however some are quartz or pyrite (Figure 9).
- Pyrite cell infiltration alignment indicates movement from original positions (Figure 9-10).
- Destroyed cell walls (Figure 9-10).
- There appears to be a directionality to the movement (Figure 9)
- Minerals observed: Plagioclase: (Bytownite- Ca rich) and (Albite-Ca poor), Calcite, Chlorite and Chloritized Hornblende (high Ca) (Figure 11-14).
- No pyrite was found in the surrounding rock
- Lack of Zoisite and amphibolite observed
- Calcite is growing in expense of chlorite (Figure 11).
- Bytownite is reacting to form albite (Figure 12).
- Chlorite is growing in the expense of hornblende and plagioclase (Figure 13).
- Plagioclase crystals and Plagioclase inclusions within chlorite have the same composition, (bytownite) (Figure 14).

Figure 7 (above): outcrop of location A (figure 2).

Figure 8 (left): outcrop of location B (figure 2).Geologist for scale.

Figure 9-10 (left top and middle top): SEM image of MH1A21 petrified wood.
Figure 11-14 (right top, left bottom, middle bottom and right bottom): SEM images of containing rock on select mineral reactions observed in thin-section MH1E1.



Interpretation

Permineralization

- Based on the fact that the petrified wood from the area is mostly blackened this suggests only a partial permineralization.
- Wood was partially permineralized before or during metamorphism because temperature required for metamorphism would destroy the wood structure.
- The low amount of Quartz is due to the fluid composition.

Metamorphism

- Chlorite is a greenschist metamorphic mineral that begins to form at 250°C and at least 1.5 kbar (Figure 14).
- Because the plagioclase is an inclusion in the chlorite, the plagioclase was most likely part of the original volcanic material and was metamorphosed in a prograde reaction.
- It is possible that the chlorite formed in a retrograde reaction, however there are no reactions observed forming the plagioclase. This would mean the unit would have to be at the T-P long enough to completely metamorphose.
- The plagioclase being higher in calcium suggests an intermediate to mafic composition of the source material.
- Mg-rich Chlorite along with high pCO_2 could suppress actinolite growth.

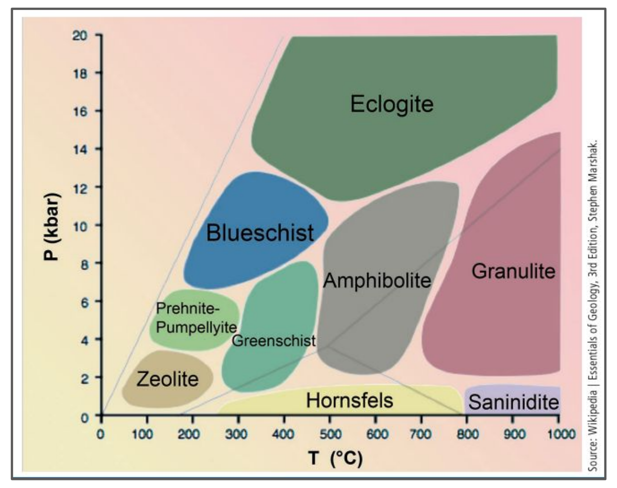


Figure 15: Pressure temperature gradient for metamorphic facies (Marshak 2016)

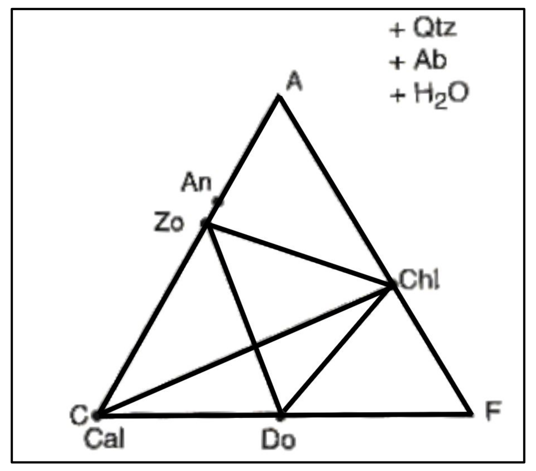


Figure 16: ACF diagram showing lowermost greenschist facies at conditions below appearance of actinolite.(Severin 2014)

Hydrothermal Alteration

- The permineralization of the wood and the influx of $CaCO_3$ in containing rock suggests a hydrothermal deposit alteration of bulk composition (Figure 16).
- The excess of calcium within the samples could be explained by an observation of a partial reaction from Plag reaction bytonite to albite.
- The fluid mechanics are unknown such that the volume seen here could be from a much larger area Fluid introduction of $CaCO_3$.
- A hydrothermal alteration could explain the "veins" (directionality) in the wood.
- High temperature low pressure Metamorphism could also be explained by a hydrothermal metamorphism.

Conclusion

Unit was formed in a volcano-clastic mass wasting event that entrained large wood debris. The textural relationship and chemical similarity between the wood and the containing rock suggests that the wood was permineralized within the rock. Bytownite the original volcanic sediments were most likely intermediate - mafic composition. Chlorite and textural relationship with bytownite was found within the containing rock suggesting a metamorphic process up to greenschist facies. Veining texture within the permineralized wood, metamorphic minerals, and an increased bulk composition of $CaCO_3$ suggest possible hydrothermal alteration. USGS map does not correctly identify the lithological unit at this location.

Acknowledgments

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