Volcanism, volcanic ash, and its role in forest ecology and management

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Emily Warrender September 1, 2025

Figure 1. Crater Lake (Mount Mazama) viewpoint in southwestern Oregon, United States. Approximately 1,000-1,200 meters of the dome collapsed or was destroyed in the final circular ring fissure eruption of 7,700 years BP (image courtesy of Pixabay).

Mark Kimsey, the Director of the Intermountain Forestry Cooperative, discusses volcanism, volcanic ash, and their roles in forest ecology and management

Volcanism and the Pacific Northwest, U.S.

Plate tectonics, the Ring of Fire, and volcanism have shaped and continue to shape Earth's landscapes, particularly along the Pacific Rim. Volcanism has shaped the skylines and landscapes of the North American Pacific Coast; depositing during eruptive events, volcanic tephra ranging in centimeters to tens of meters in depth. One particular eruptive event that dramatically changed Northwest U.S. ecological history was the repeat and final circular ring fissure eruption of Mount Mazama (known currently as Crater Lake) in southwestern Oregon State approximately 7,700 years ago (Fig. 1).

This final eruption reached nearly 50 kilometers (30 miles) into the atmosphere, with downwind deposition affecting all western and Rocky Mountain States and the three western Canadian Provinces. Evidence of Mount Mazama volcanic ash has been found globally. It is estimated in this final eruptive event that over 120 cubic kilometers (~30 cubic miles) of volcanic tephra was produced, enough to cover the entire State of Oregon (or the entire UK!) to a depth of 45 centimeters (1.5 ft). To this day, many regional western United States landscapes have deep volcanic ash deposits (termed andic soils) (Kimsey et al., 2011).

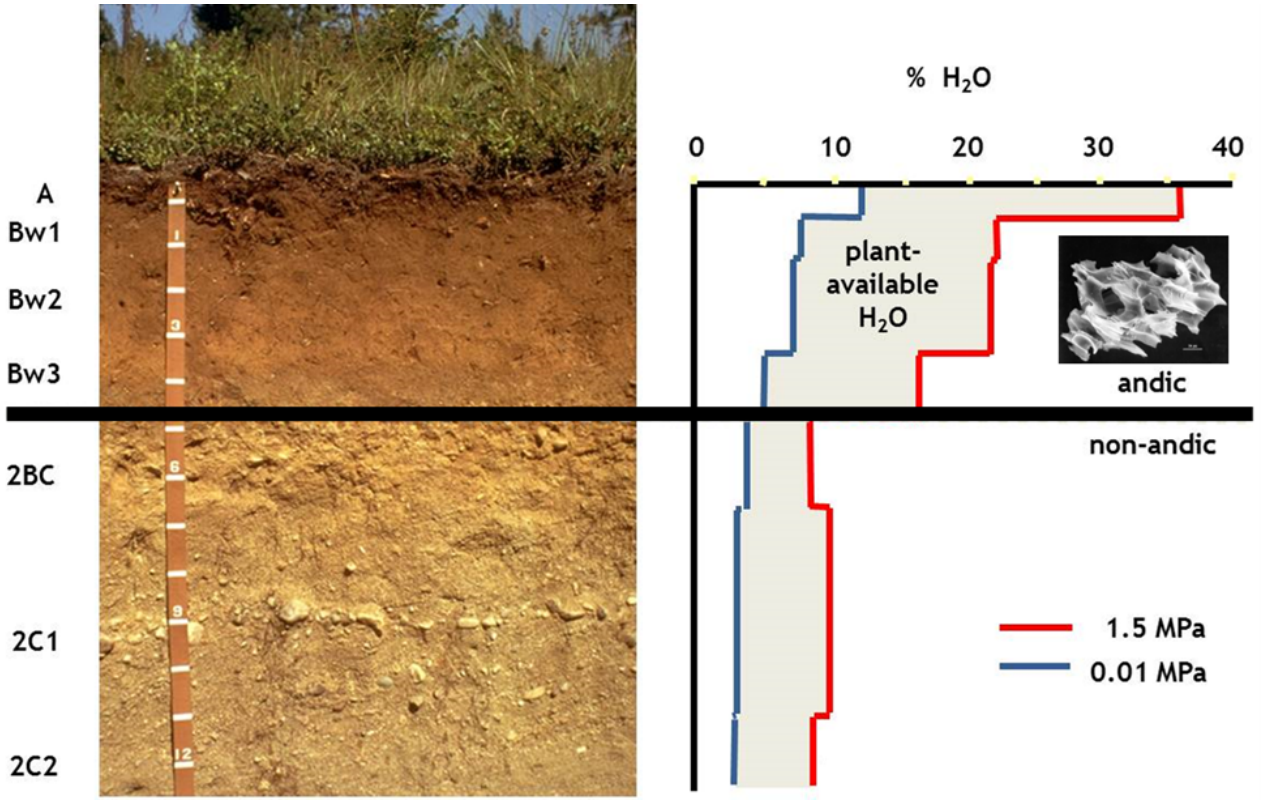

Figure 2. Plant available water in a fine-textured volcanic ash soil (andic) overlaying a coarse- textured glacial till soil (non-andic) in Northern Idaho, United States. Andic soil properties extend to approximately 45 cm in depth. Inset micrograph: volcanic glass particle (courtesy of the University of Idaho Soil Characterization Laboratory, Moscow).

Key soil properties of volcanic ash

Soil volcanic ash has unique soil characteristics given its violent origin. If looked under a microscope, the majority of soil particles look like glass shards shot through with holes (vesicles). In addition, downwind volcanic ash deposition tends to have smaller particle sizes, falling primarily in the silt category (0.002 – 0.05 mm). These two primary features of volcanic ash lead to significantly higher soil water holding capacity, relative to other non-volcanic-ash-derived soils (Fig. 2).

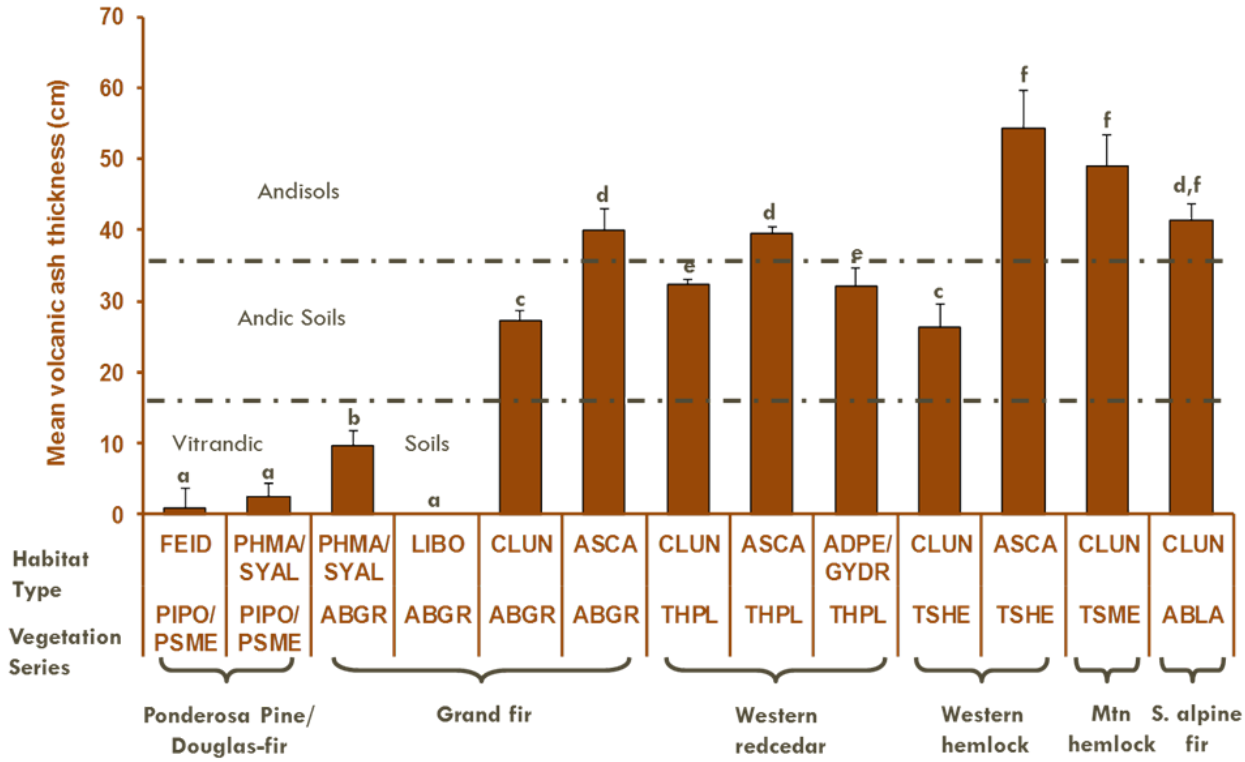

Figure 3. Vegetation community shifts by increasing fine-textured volcanic ash depth and purity across the Intermountain Northwest, United States (Kimsey et al., 2007).

The role of volcanic ash in forest ecology and management

The ability of these volcanic ash soils to hold two to three times the plant available water relative to other soil parent materials is the primary key to changing the productivity and species composition of Western United States forest ecology. The presence of fine-textured volcanic ash has been linked to vegetation plant community shifts and increased growth rates, supporting plant species that require more plant-available water than would have been typically available in geologically derived regional soils found across the Mediterranean and Continental climates of the Western United States (Figs. 3 and 4).

Given the significant influence of volcanic ash on forested ecosystems, it is important for natural resource managers to map and incorporate their presence into silvicultural management information systems. Volcanic ash, or soils with similar water retention characteristics, are a relatively non-renewable resource that must be protected to maintain their ecological and silvicultural importance, particularly in regions that experience, or will experience, droughty conditions.

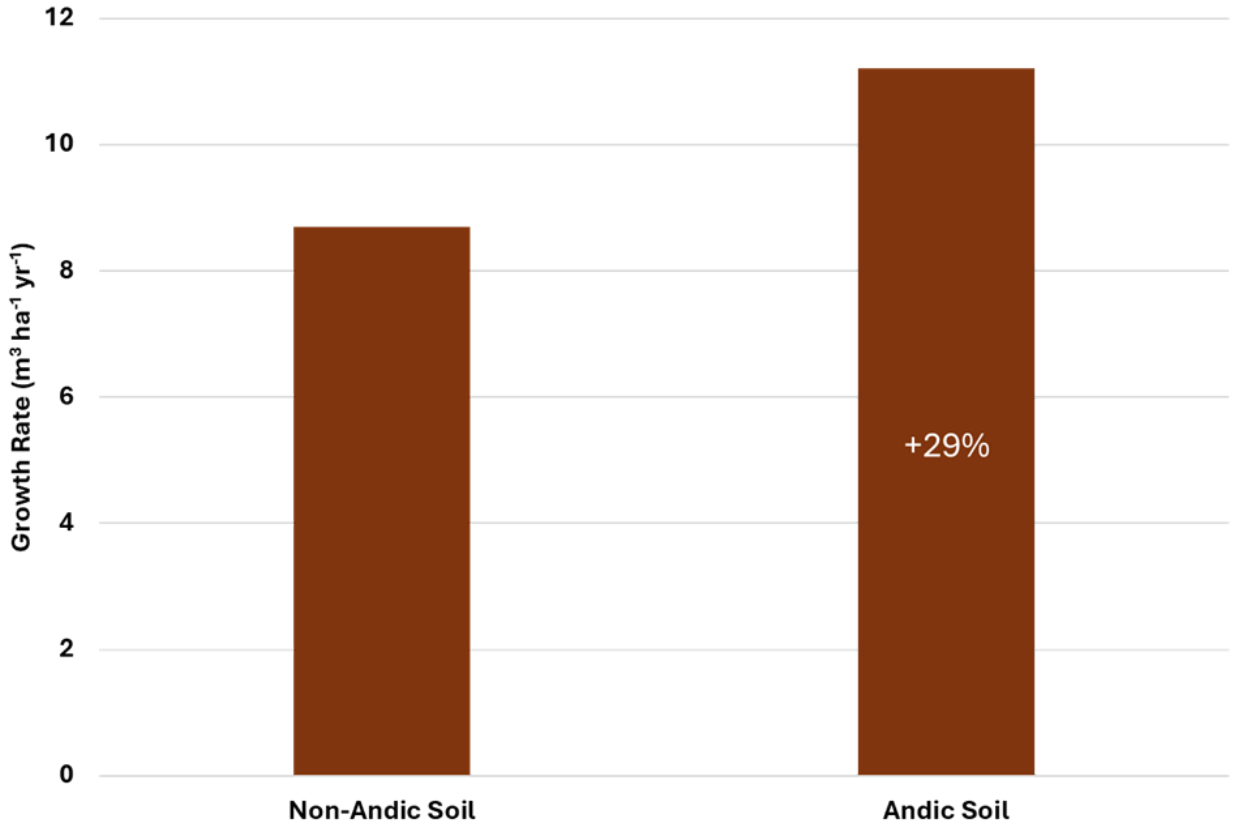

Figure 4. Influence of volcanic ash on mixed conifer growth rates across the Intermountain Northwest, United States (research data provided by the Intermountain Forestry Cooperative).

References

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