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Petrifaction of wood by calcium carbonate mineralization: Examples from spring-associated limestones of the Eastern Alps

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The petrifaction of tissues such as wood can unveil much information on fossil assemblages. Wood most commonly is petrified by silicification, in settings ranging from hot springs to shallow burial. In contrast, we herein characterize wood petrified by calcium carbonate mineralization from spring limestone deposits of the Eastern Alps.

The spring-associated limestone (SAL) deposits with calcified wood are post-Glacial (highest $^{234}U/^{230}Th$ errorchron age: 13.4 ± 0.2 ka) and inactive, and scatter from 800-2200 m a.s.l. Individual deposits range in mineralogy from aragonite plus magnesian calcite to primary low-magnesian calcite. The springs most probably had shed 'cool' waters at or near the ambient mean temperature of their recharge areas. In the Eastern Alps, cool springs with Mg/Ca ratios of 3-5 that actively precipitate aragonite and magnesian calcite are known from a location with a mean annual temperature of 8°C.

Wood petrifaction by calcification affected branches to tree logs up to a few decimeters in diameter. Thicker branches and logs, however, are calcified only in a peripheral fringe up to $\sim$10 cm in width, whereas the inner part is a phytomould or filled with other types of spring limestone. The preservation of cells, tracheids and vessels ranges from good to poor and patchy, and commonly allows for distinction of wood of conifers (gymnosperms) from woody angiosperms. Before petrifaction the wood was subject to partial physical disintegration, as recorded by desiccation cracks and local rotting/decomposition of cell walls. In addition, some degree of biological decomposition is indicated by tunnels and patches with calcified pellets (probably of arthropods), and by diffuse patches of micrite perhaps recording fungal and/or microbial infestation. The partial decomposition, in turn, favoured percolation of $CaCO_3$ supersaturated water through the wood, and consequent mineralization.

Silicification of wood within a few years was documented by other authors from hot springs highly supersaturated for SiO_2. We similarly infer that the *calcification* of wood proceeded to a stage wherein the cell lumina are filled by calcium carbonate within a few years to (at most) a few tens of years after emplacement in spring of high $CaCO_3$ supersaturation. A significantly longer interval of time (e. g. hundreds to thousands of years) for calcification is also improbable because of: (a) the variability of shedding and/or degree of supersaturation of limestone-depositing spring, and (b) wood decomposition that would outpace a potentially very slow calcification. As mentioned, thicker pieces of wood are calcified only along their periphery; this suggests that when permeability was sufficiently lowered in the interior by calcification of the fringe, the remaining inner part of a wood fragment rotted out. Carbonate polymorphy (aragonite, magnesian calcite, calcite) seemed not to exert a marked influence on petrifaction. Once embedded in spring limestone, the microstructure of the calcified wood can persist over thousands of years or more. Spring limestones thus might also comprise information on intramontane vegetation predating the Last Glacial Maximum.