



Supplement of

A comparison of pre-millennium eruption (946 CE) and modern temperatures from tree rings in Changbai Mountain, Northeast Asia

Haibo Du et al.

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This document provides supporting analysis and figures for the main article.

Identifying Korean pine tree species from carbonized trees

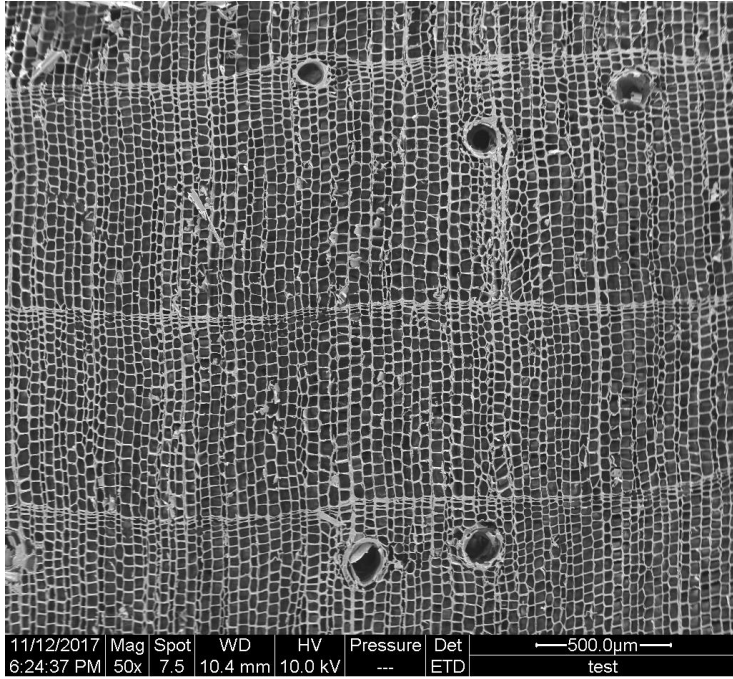
In this study, the tree species of carbonized trees was identified by analyzing the microscopic anatomical features of wood on three planes (cross-, radial-, and tangential-section). For the identified Korean pine (*Pinus koraiensis* Siebold & Zucc.) in this study, the microscopic anatomical features were showed below:

Cross-section features. The boundary of growth ring is slightly obvious, and the early wood gradually changes to late wood within the ring. The growth of early wood is uniform, and the early wood accounts for most of the ring width. The axial parenchyma tissue is absent. The resin channels are divided into axial and radial types. The axial channels are mostly single and usually distributed in the late wood or located at 2/3 of the ring width. The lipid cells are thin-walled and often contain quasi-invasion bodies. There are 3~6 lipid cells around the maximum axial resin channel. The transverse section of early wood tracheid is square, rectangular and polygon, and the axial parenchyma tissue is absent.

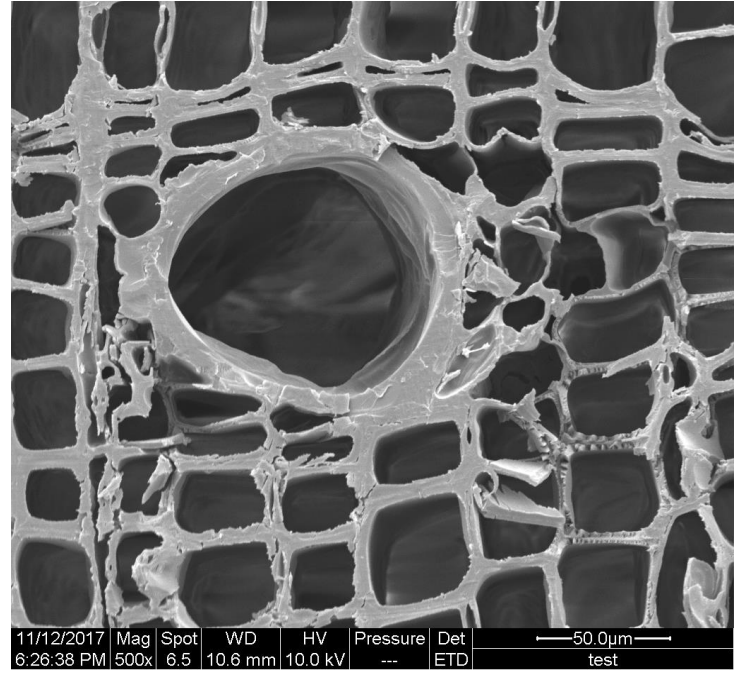
Radial-section features. Radiative tracheids are located in 1~2 columns of the upper and lower edges, and are occasionally seen in the middle of the rays. The xylem low rays are sometimes made up entirely of radial tracheids. The inner wall is smooth and the outer edge is wavy. The cross field pattern between ray parenchyma cells and early wood tracheids was pane-like, or pine type was occasionally seen in late wood, with number of 1~4, 1 (rare 2) in horizontal line. Axial parenchyma cell horizontal wall perforation and end wall nodular thickening are usually absent or few, not obvious, no indentation.

Tangential-section features. There are 4-8 wood rays per mm, including two types: single column and spindle-shaped. The single column of rays is 2~13 cells or more in height, most of them are 3~8 cells; the spindle rays have radial resin canals, 2~3 columns of ray cells above and below the approach; The upper and lower ends gradually sharpen into a single column, the height of which is 3-10 cells or more. The ray cells are usually oval in shape. The radial resin tract is much smaller, with 3-5 adipocytes around the tract.

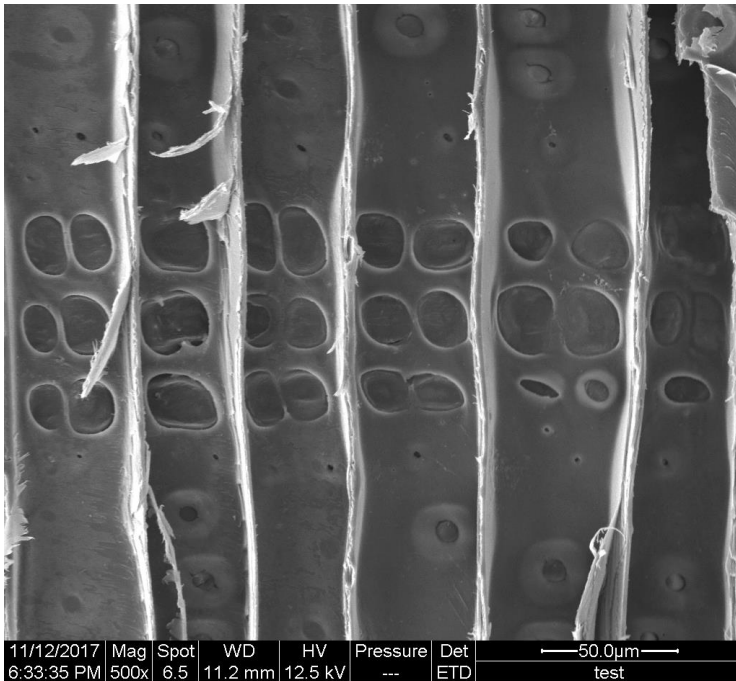
Conclusions. According to the microscopic anatomical characteristics of the above three planes, the carbonized logs, No. CBSXA-01, CBSXA-12, CBSXA-21, CBSXA-24, CBSXA-27, CBSXB-01, CBSXB-02, CBSXB-03, CBSXB-05, CBSXB-07, CBSXB-08, CBSXB-10, CBSXB-11, CBSXB-14, CBSXB-15, CBSXB-17, CBSXB-21, and CBSXB-26, were identified as Korean pine (*Pinus koraiensis*) of the family *Pinaceae* and the genus *Pinus*. The anatomical features of the tree planes of the 18 samples were separately showed below in the large Figure S1.



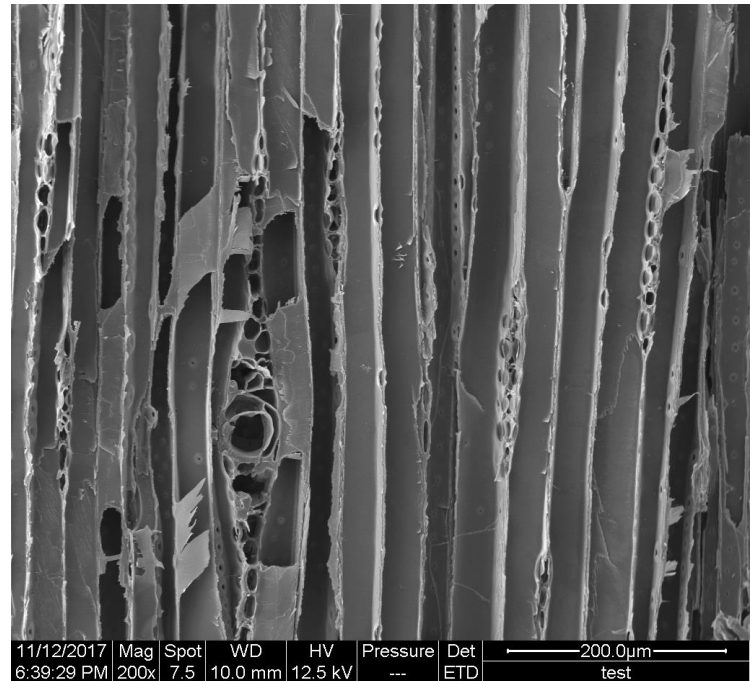
Cross-section magnified 50 times



Cross-section magnified 500 times

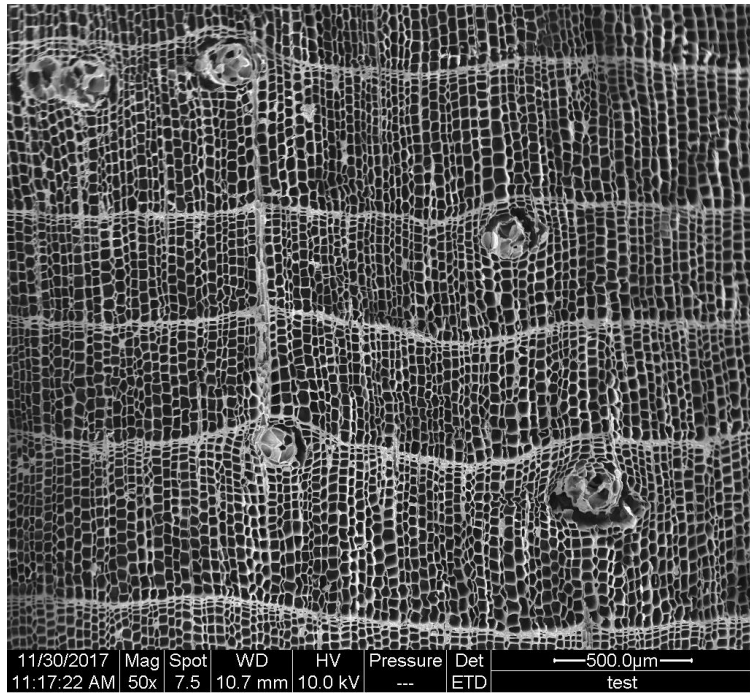


Radial-section magnified 500 times

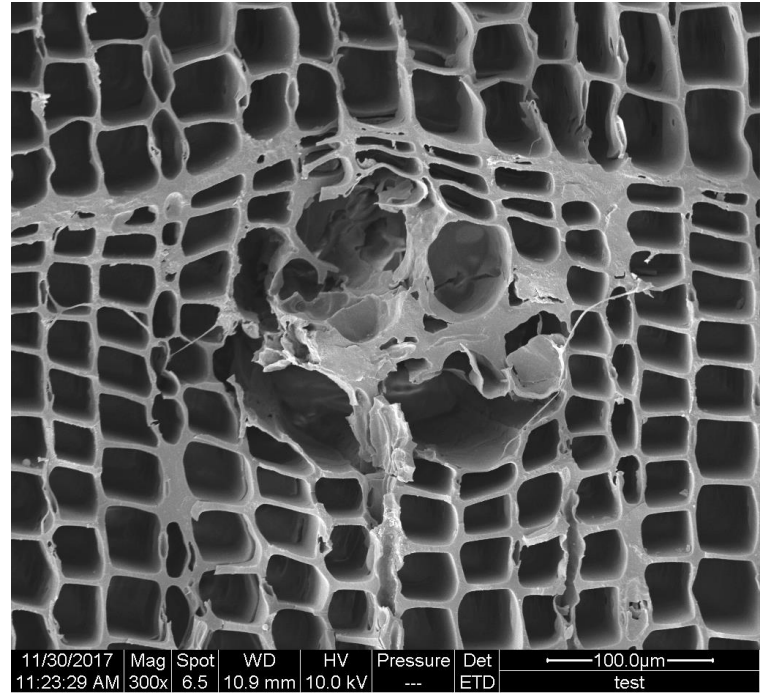


Tangential-section magnified 200 times

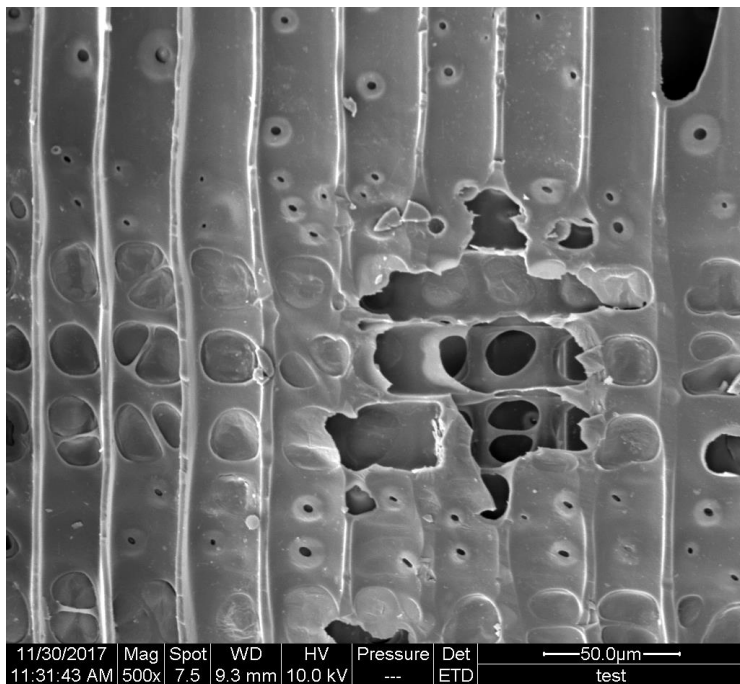
Figure S1. The anatomical features of carbonized log (No. CBSXA-01) shown on the cross-, radial-, and tangential-section



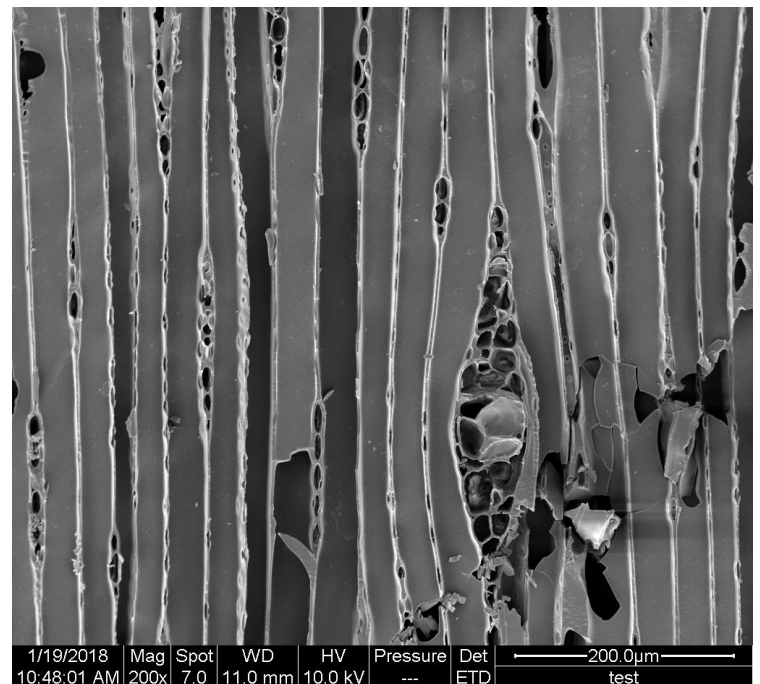
Cross-section magnified 50 times



Cross-section magnified 500 times

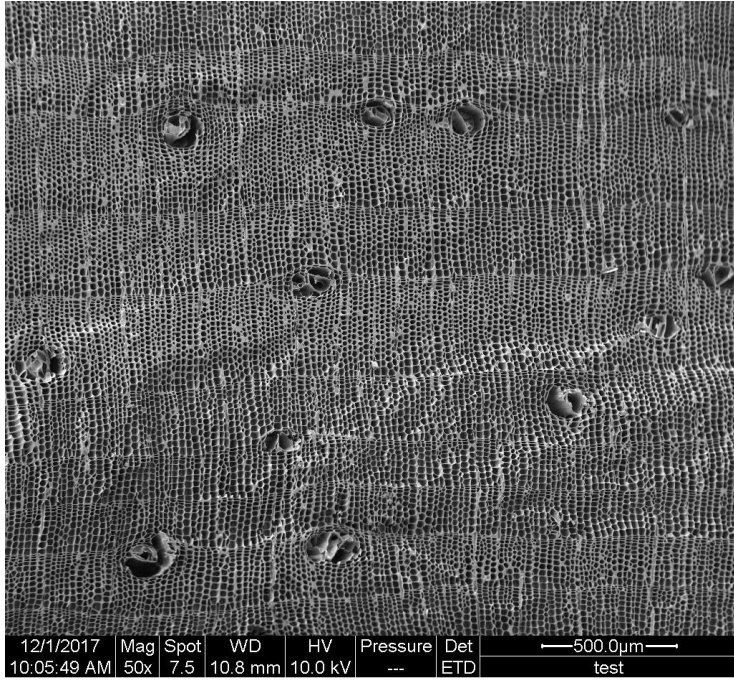


Radial-section magnified 500 times

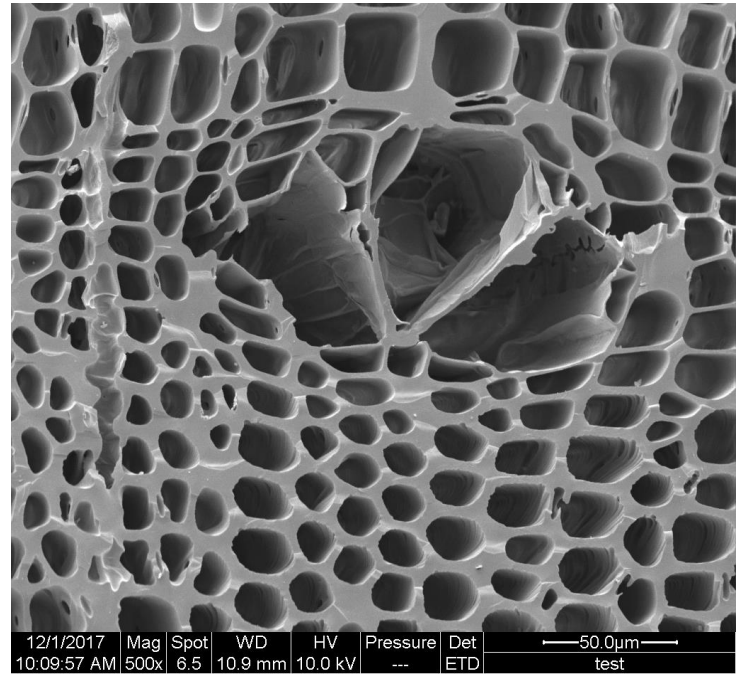


Tangential-section magnified 200 times

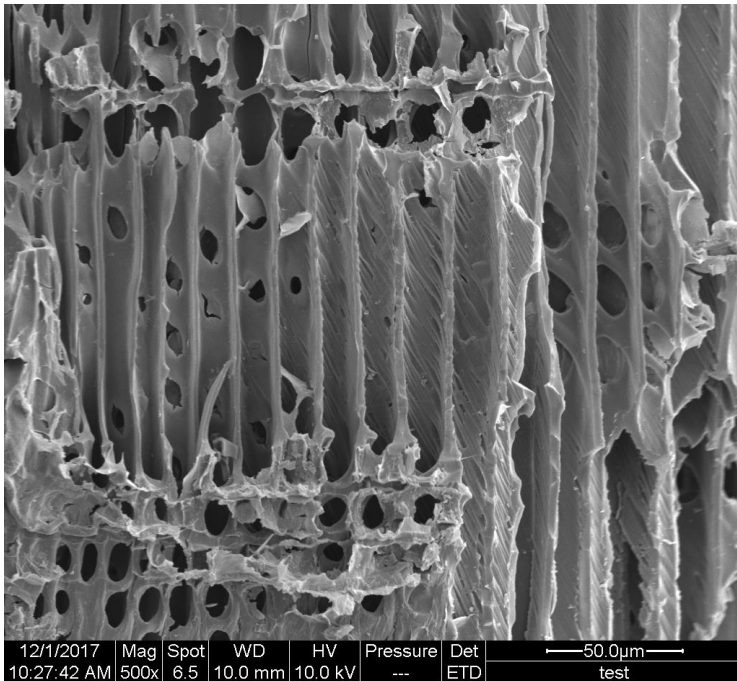
Figure S1 (continued) for carbonized log No. CBSXA-12



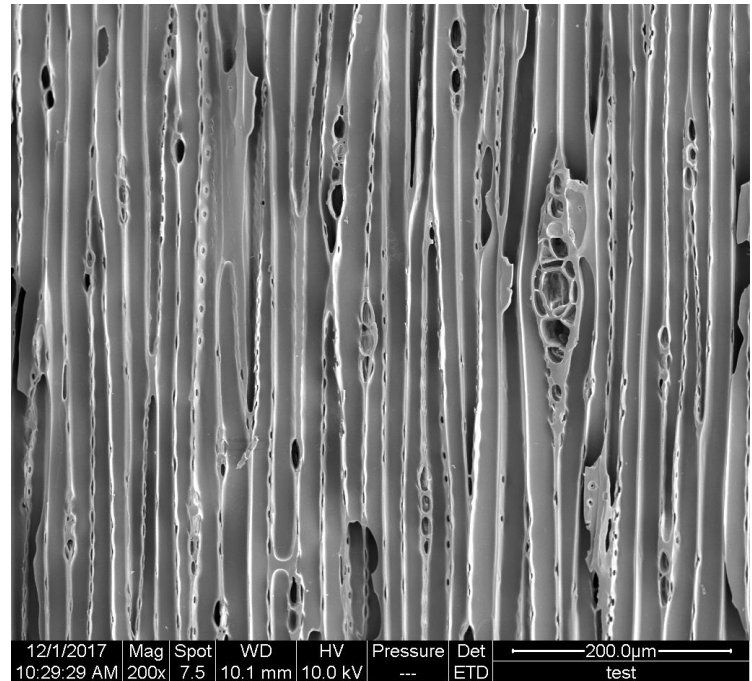
Cross-section magnified 50 times



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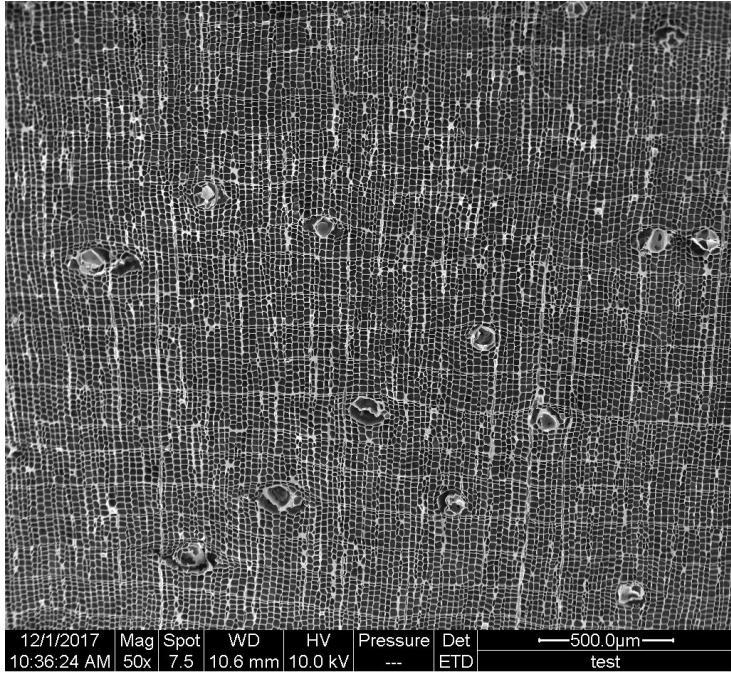


Radial-section magnified 500 times

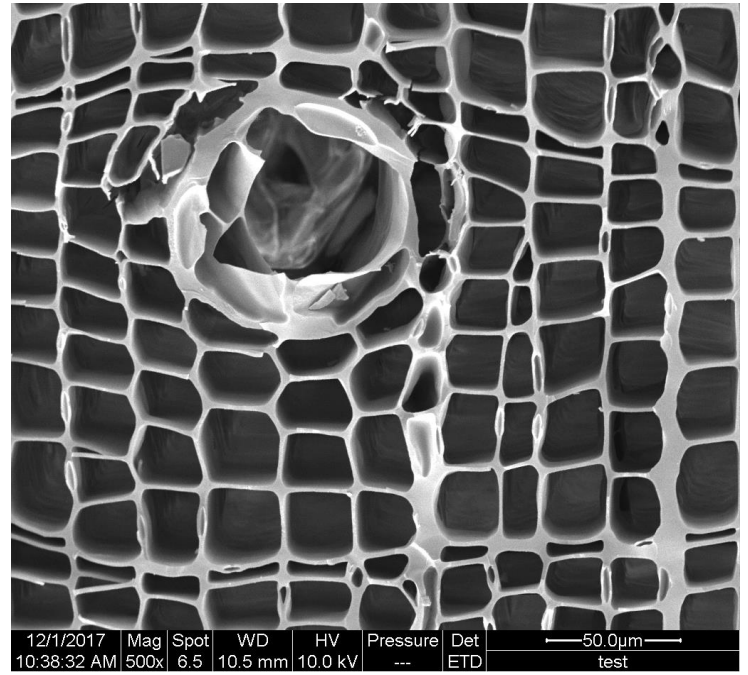


Tangential-section magnified 200 times

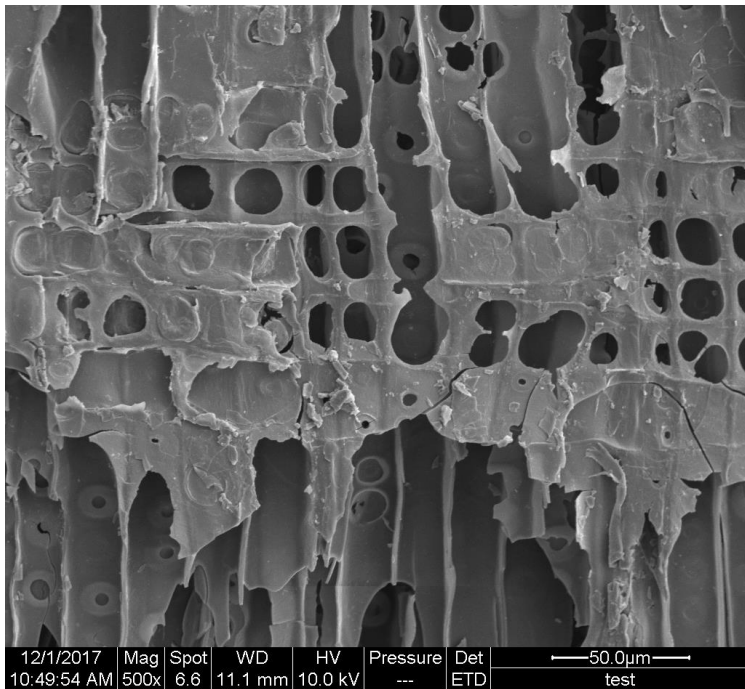
Figure S1 (continued) for carbonized log No. CBSXA-21



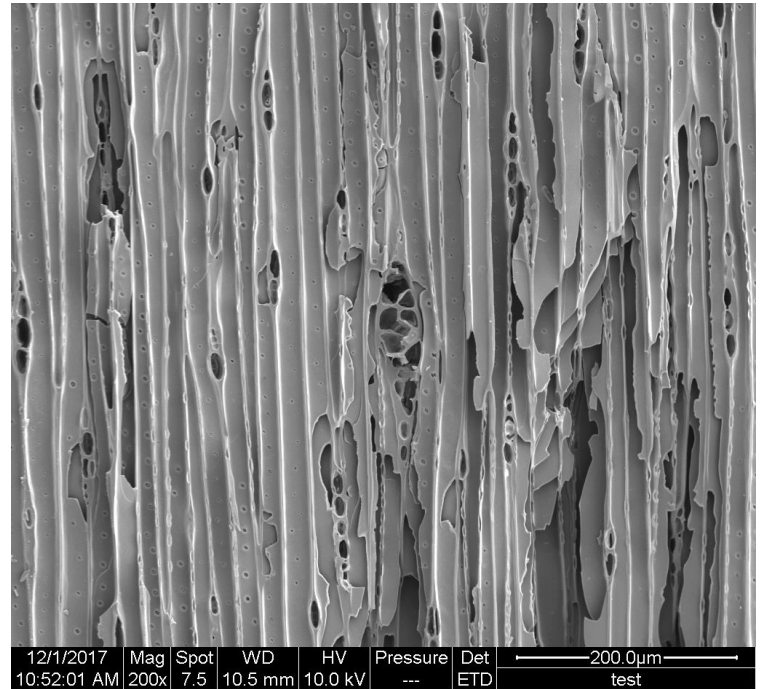
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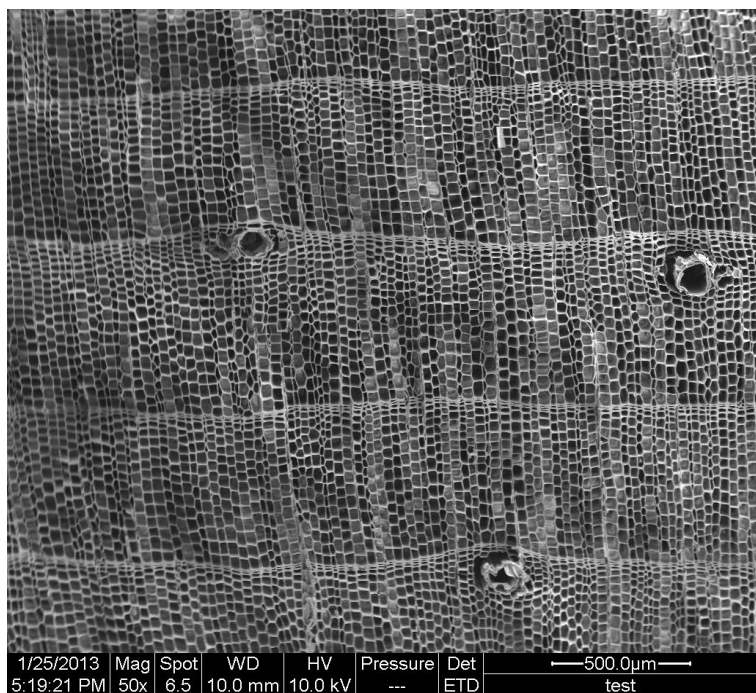


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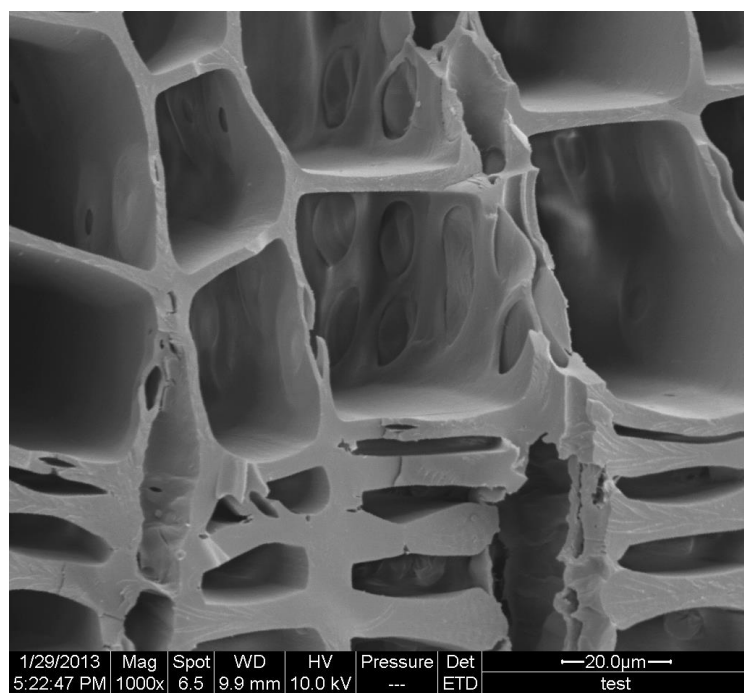


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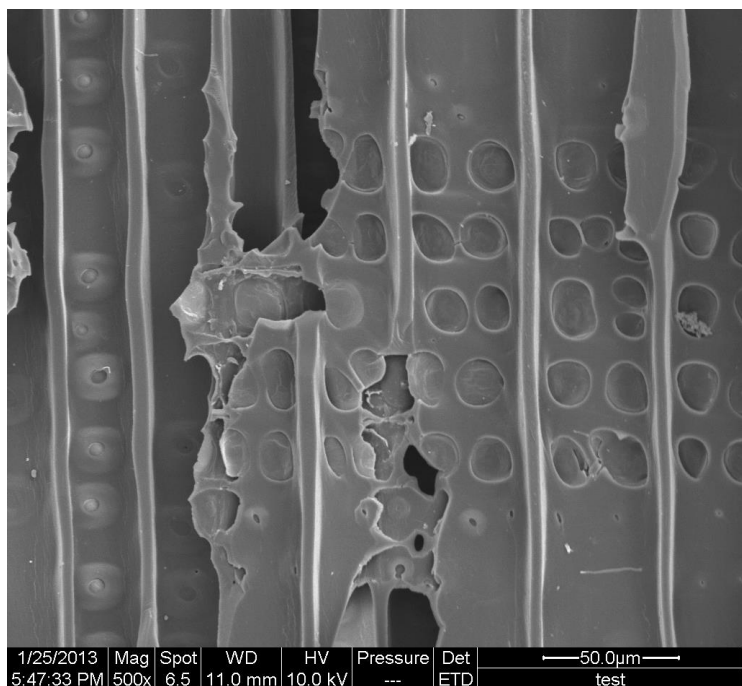
Figure S1 (continued) for carbonized log No. CBSXA-24



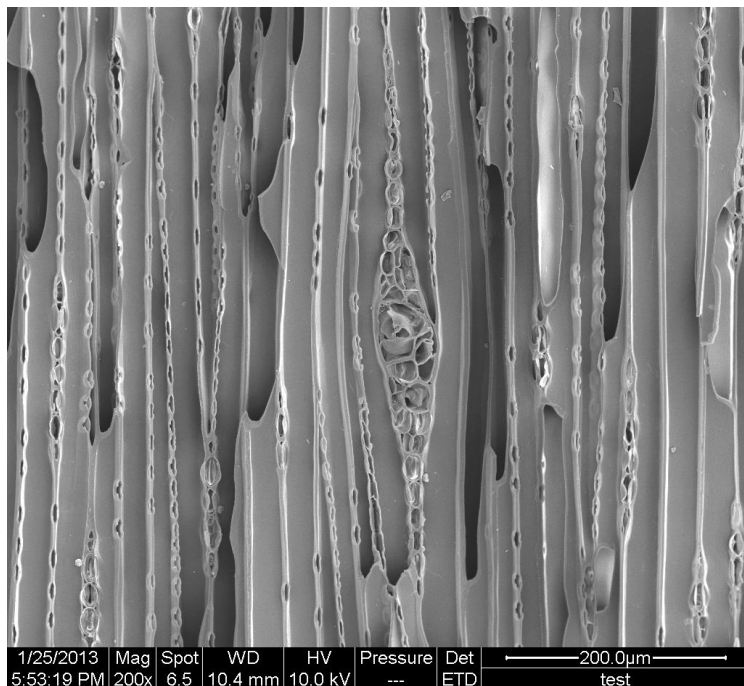
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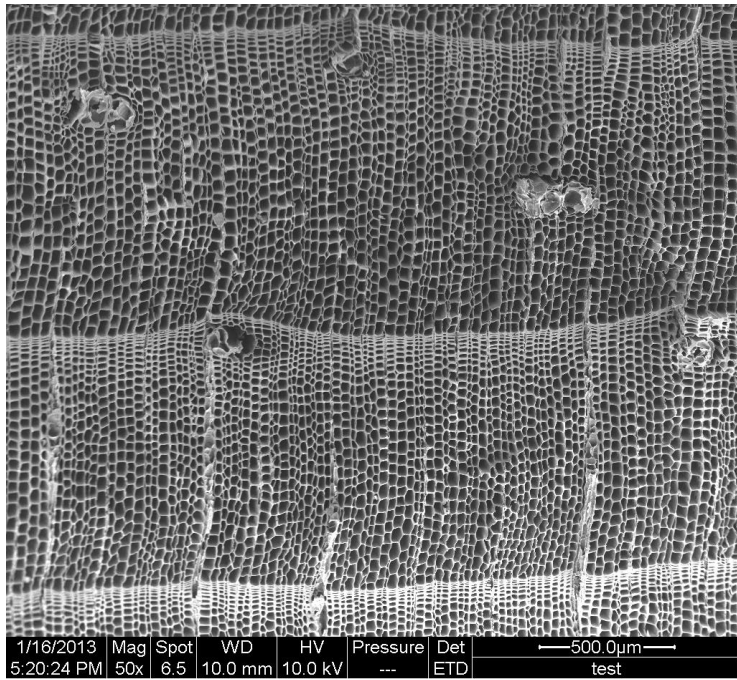


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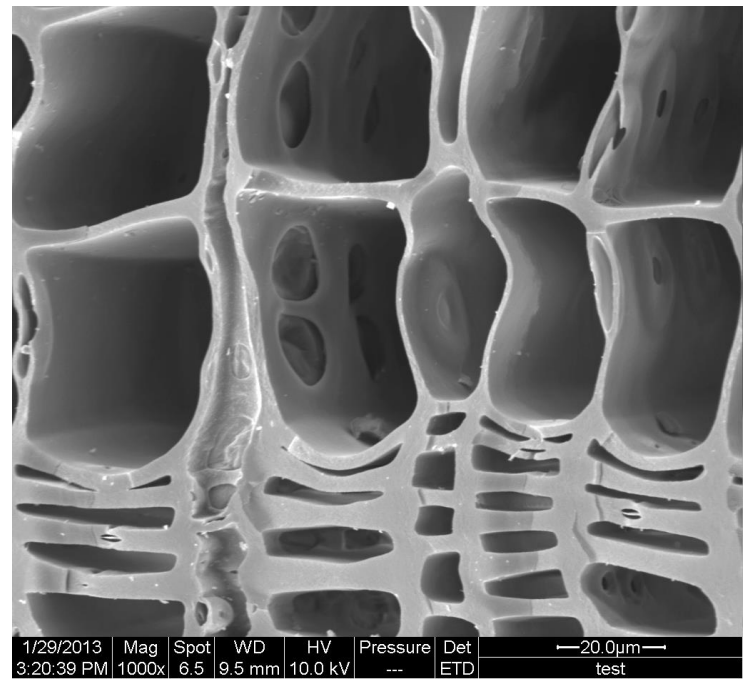


Tangential-section magnified 200 times

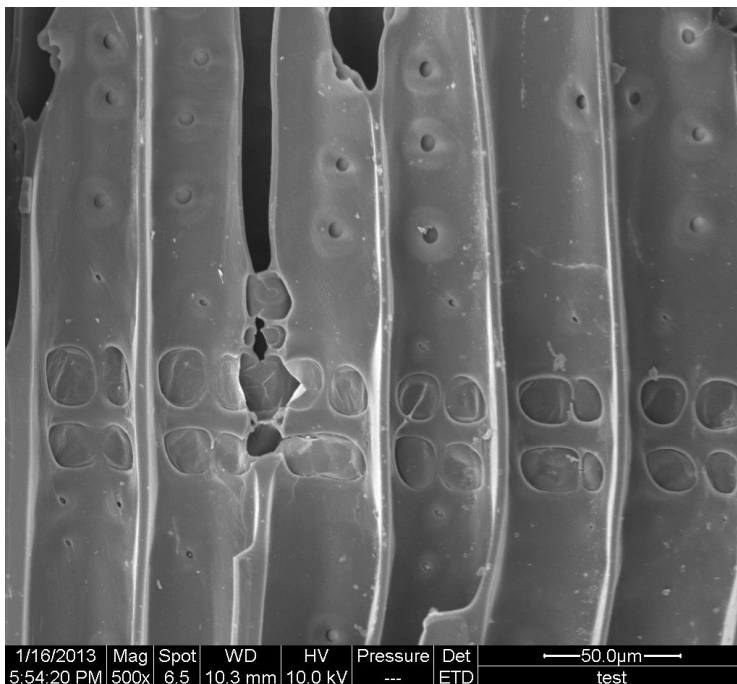
Figure S1 (continued) for carbonized log No. CBSXA-27



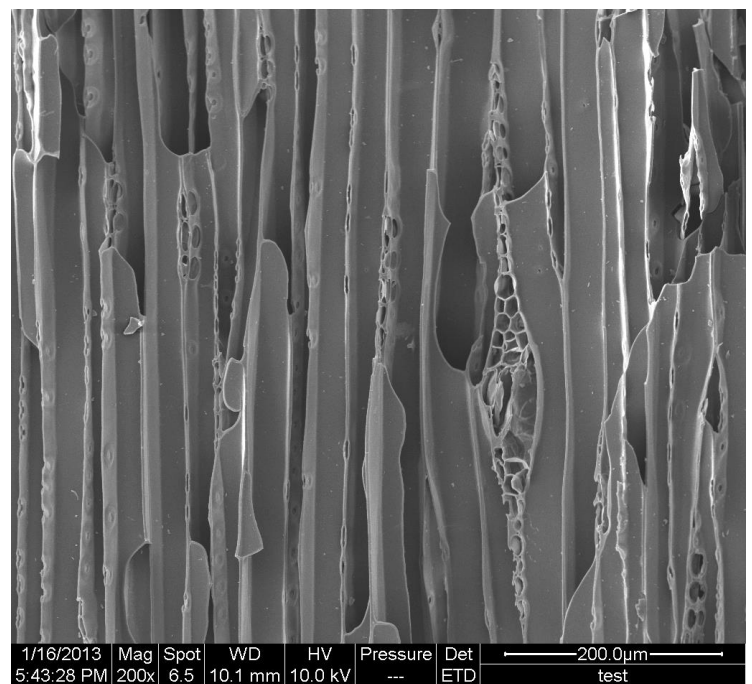
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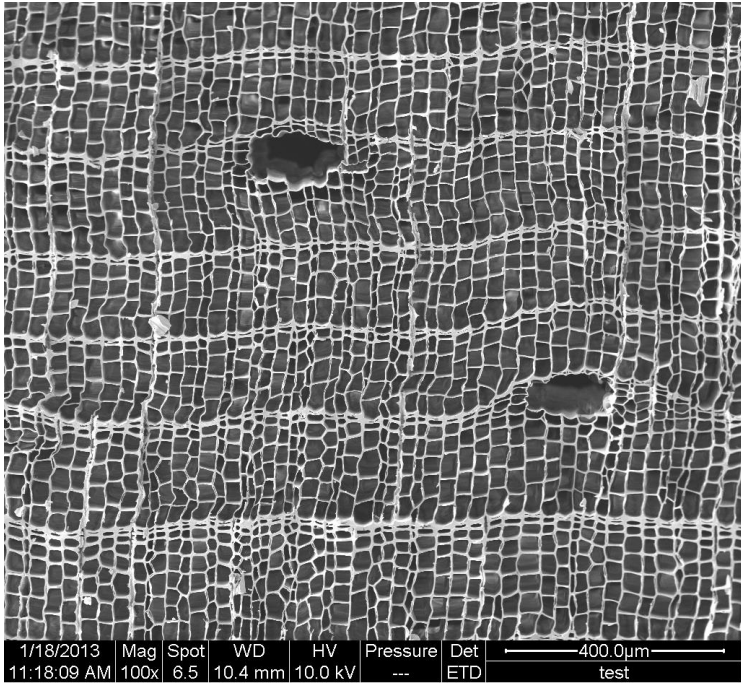


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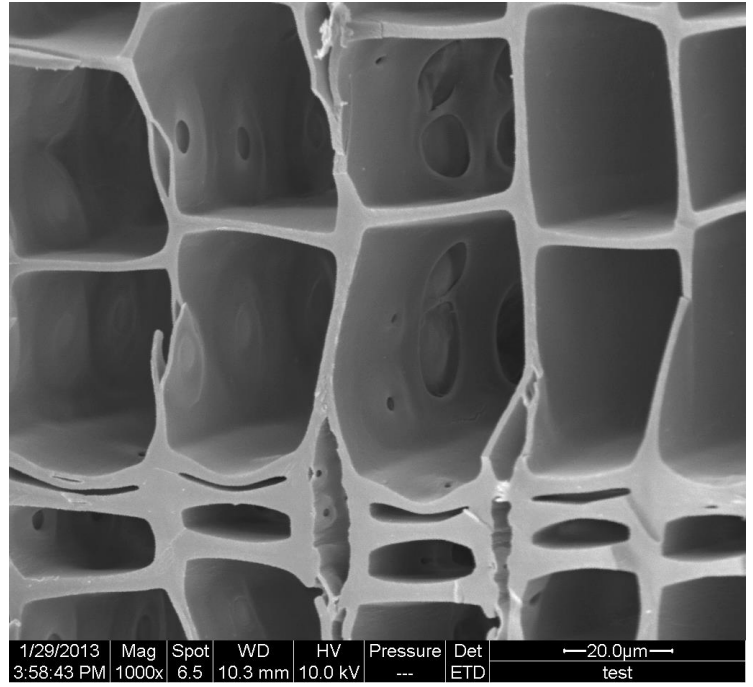


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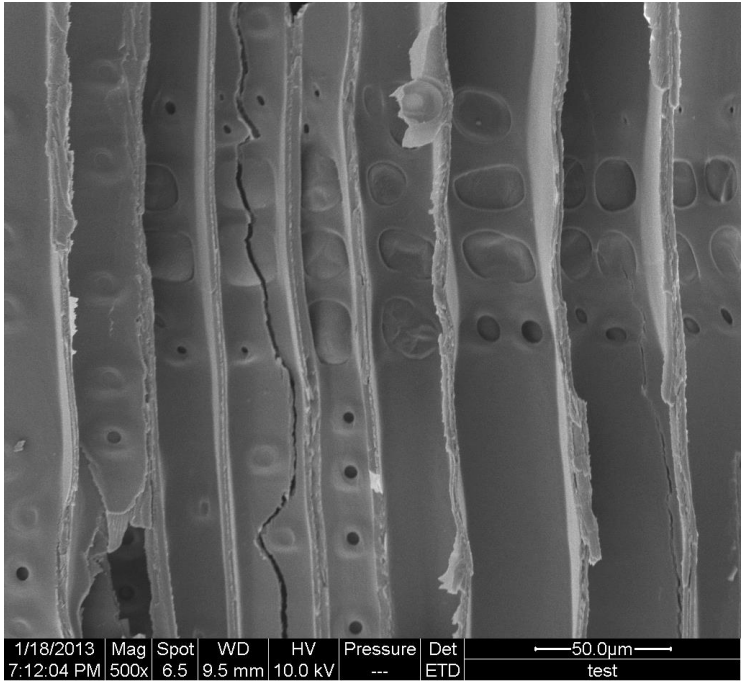
Figure S1 (continued) for carbonized log No. CBSXB-01



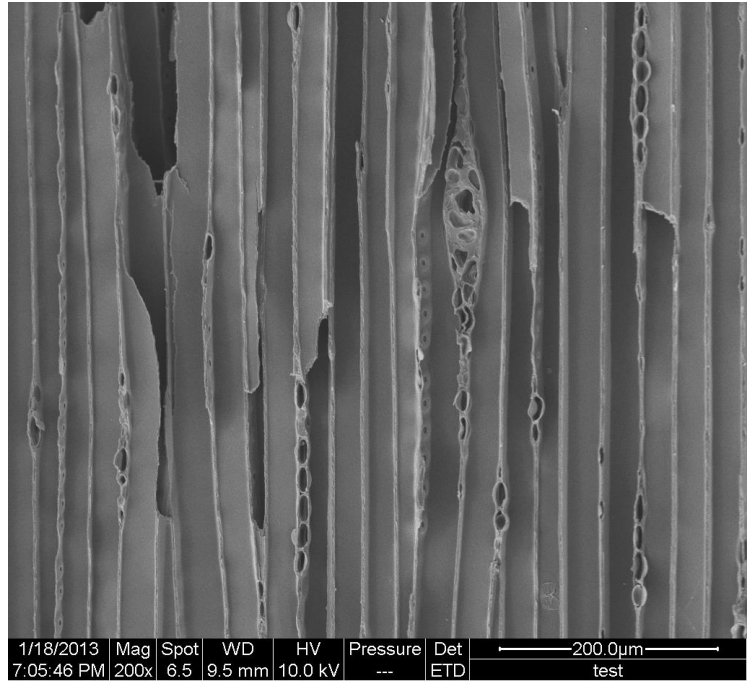
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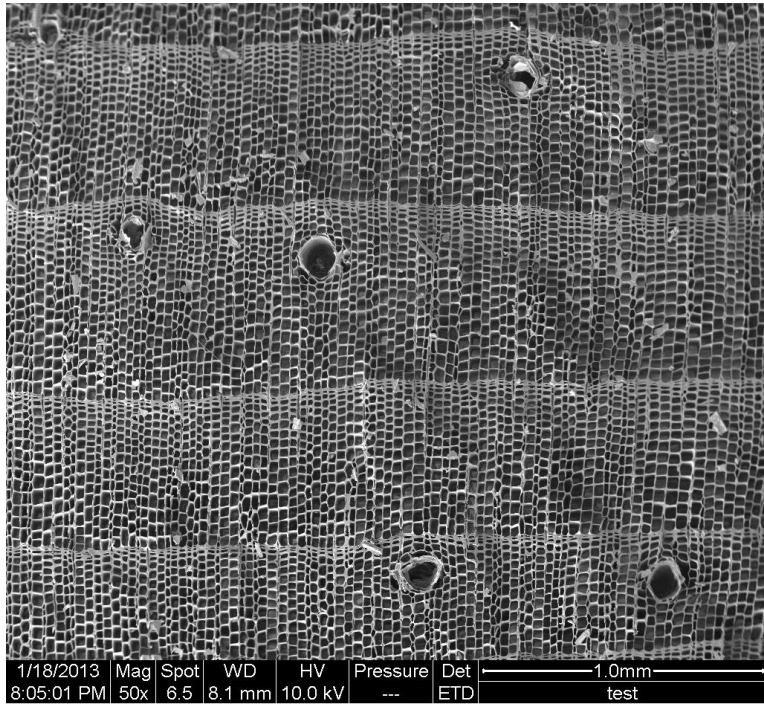


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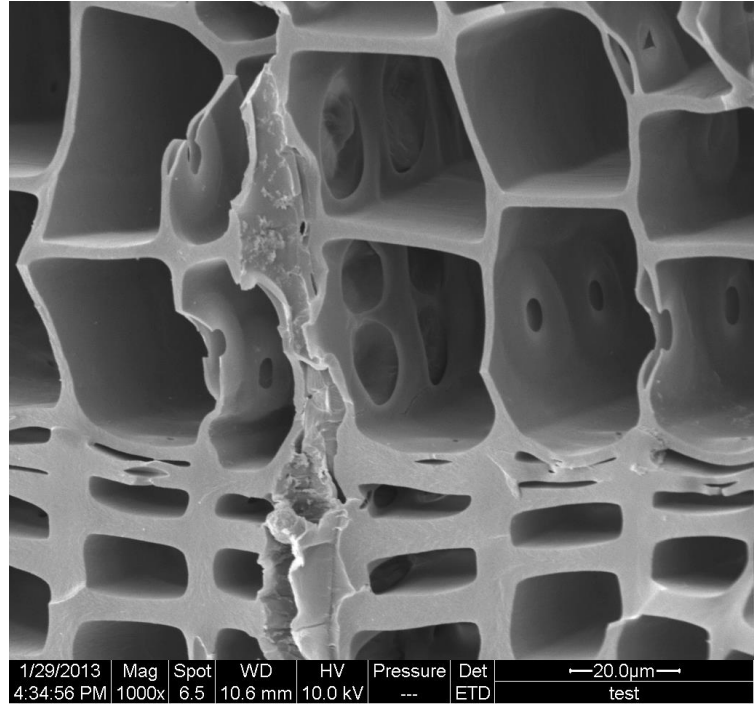


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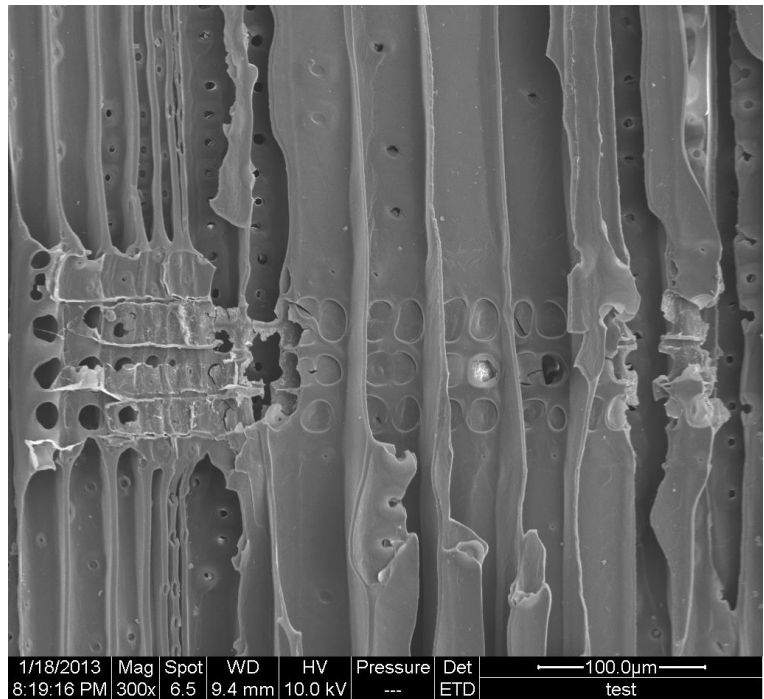
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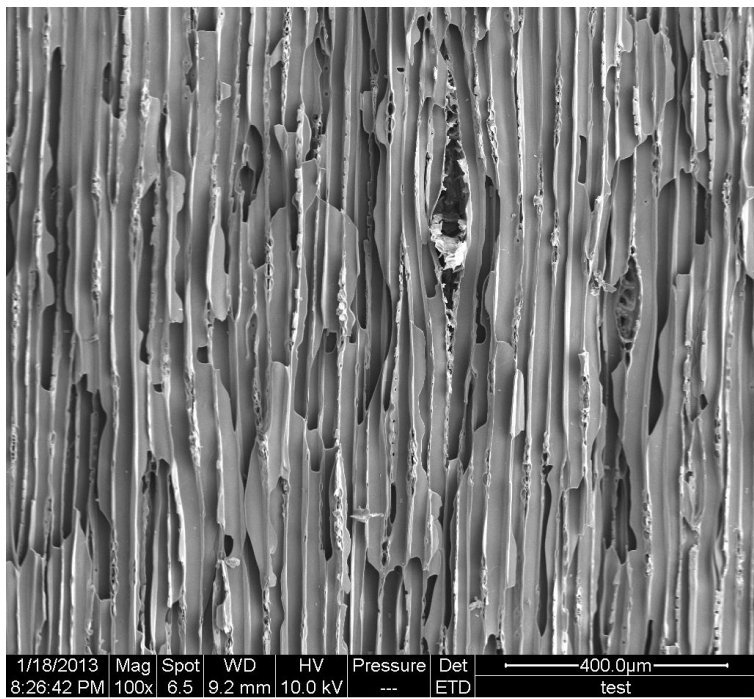
Cross-section magnified 50 times



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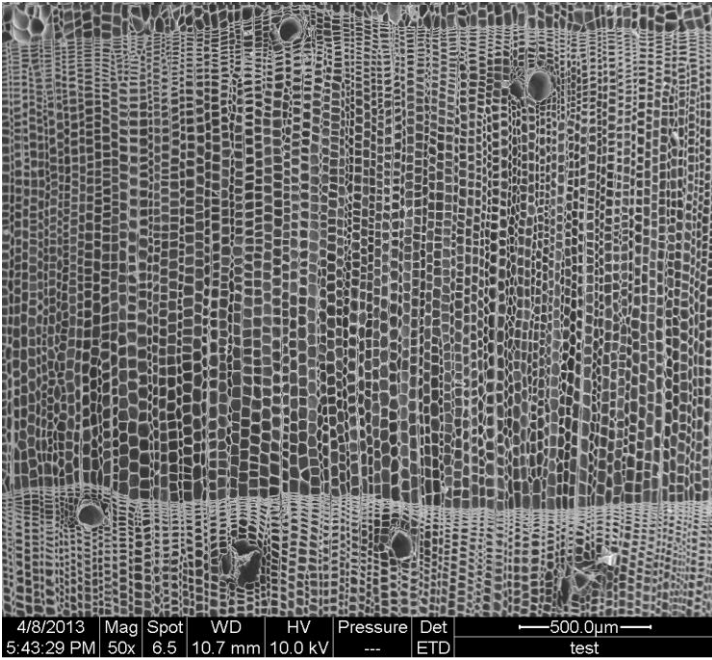


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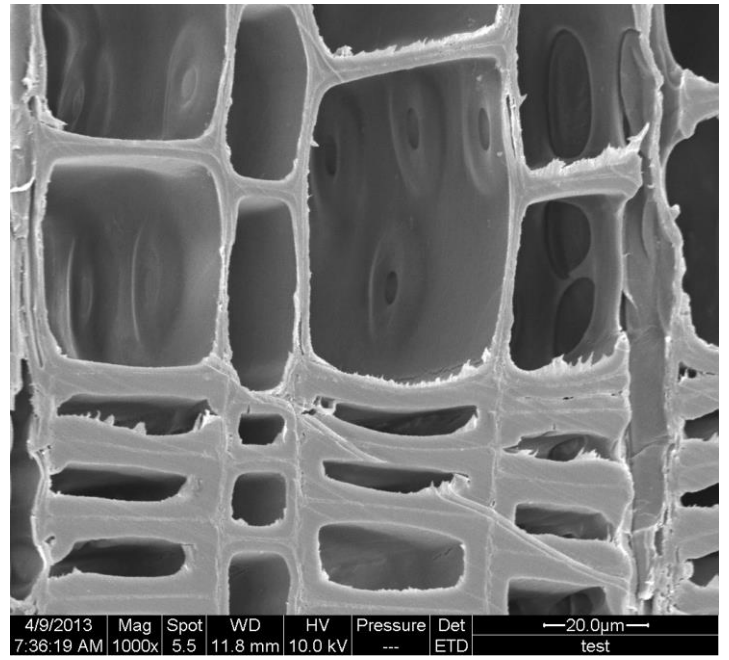


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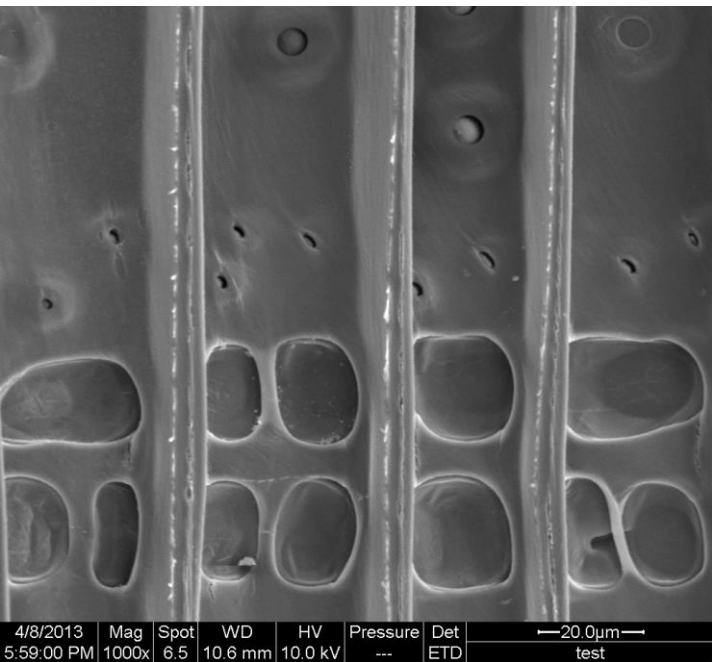
Figure S1 (continued) for carbonized log No. CBSXB-03



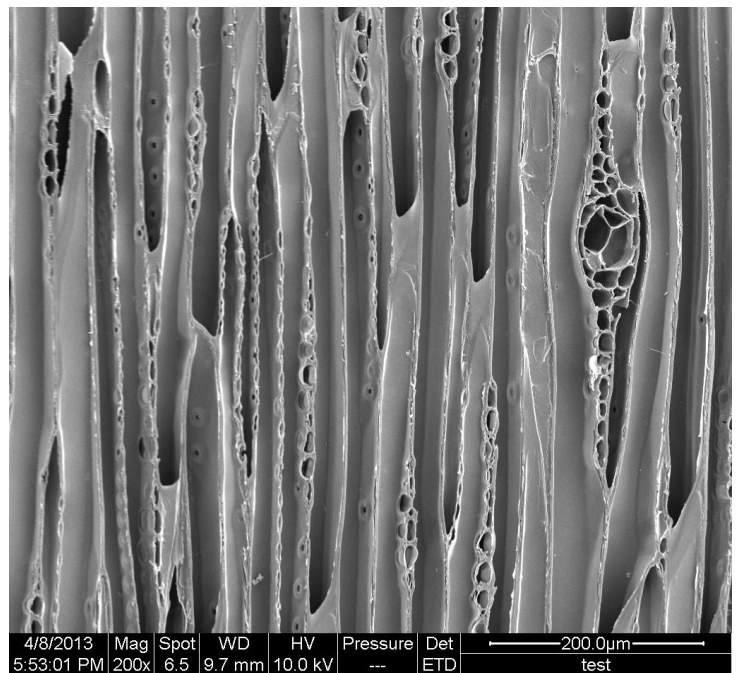
Cross-section magnified 50 times



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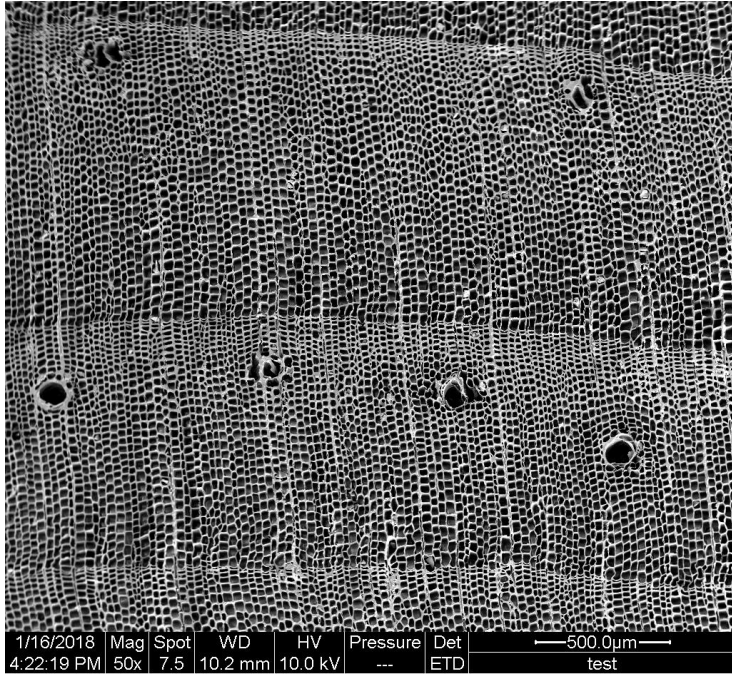


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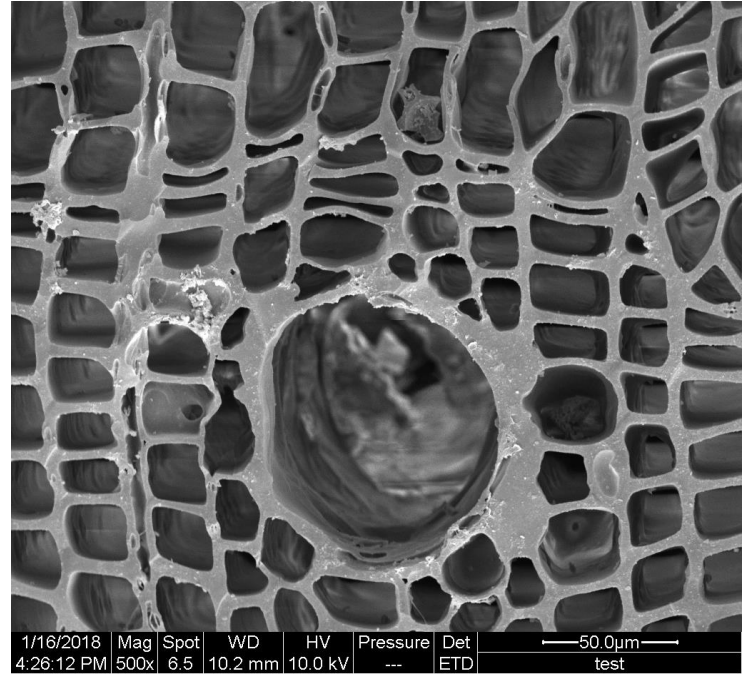


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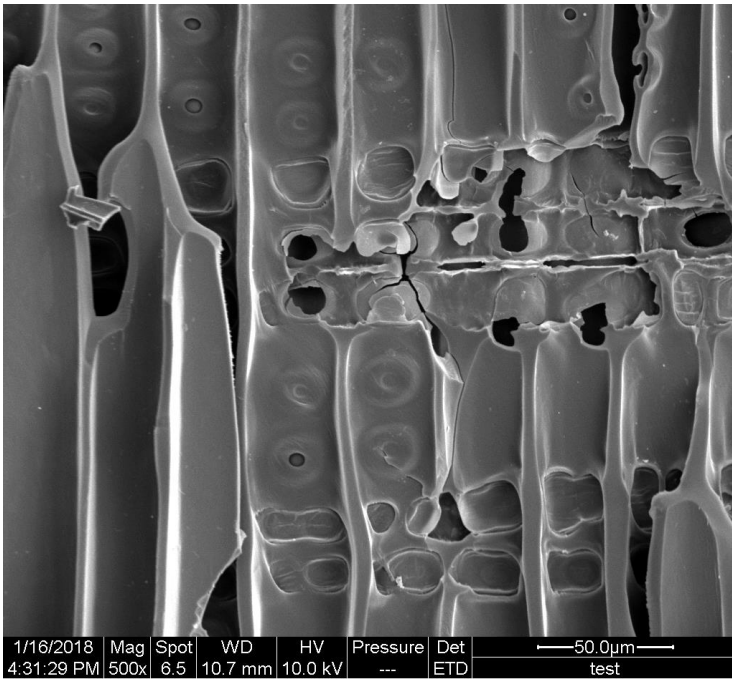
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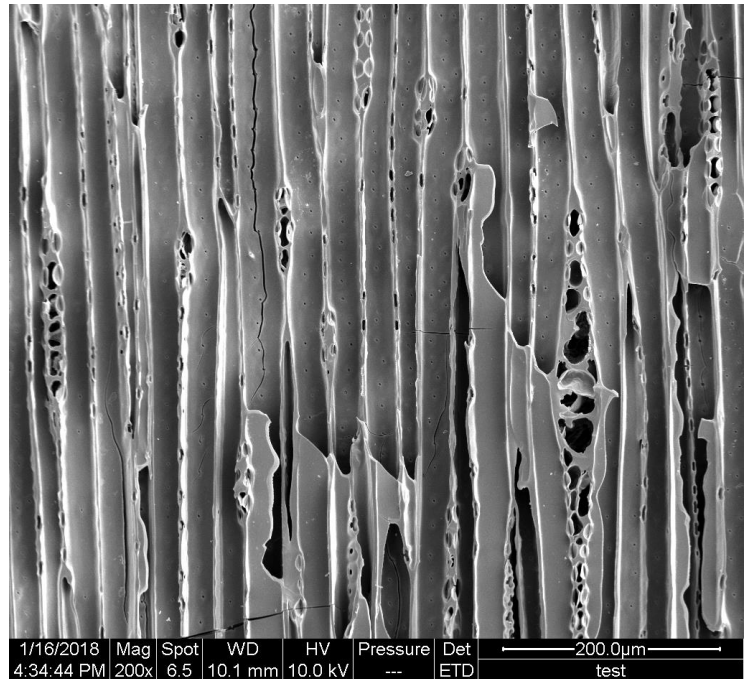
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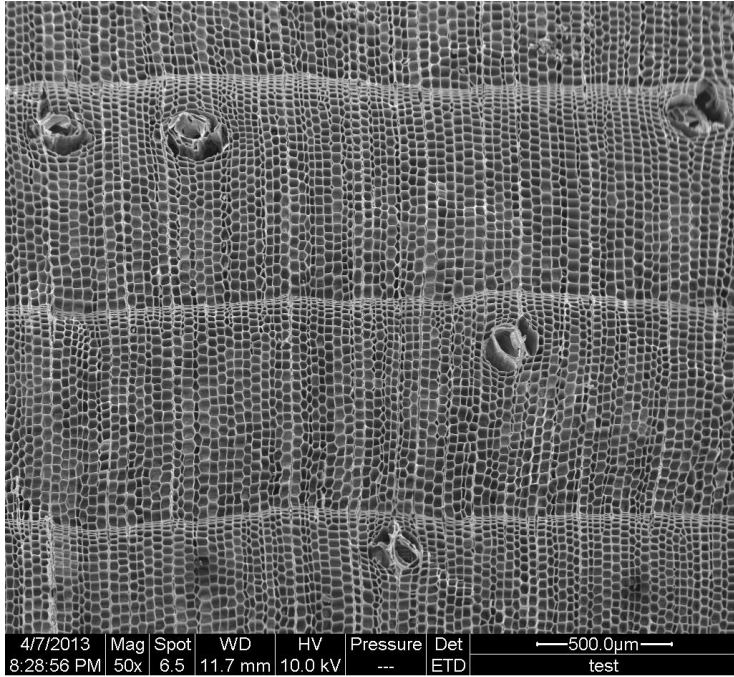


Radial-section magnified 500 times

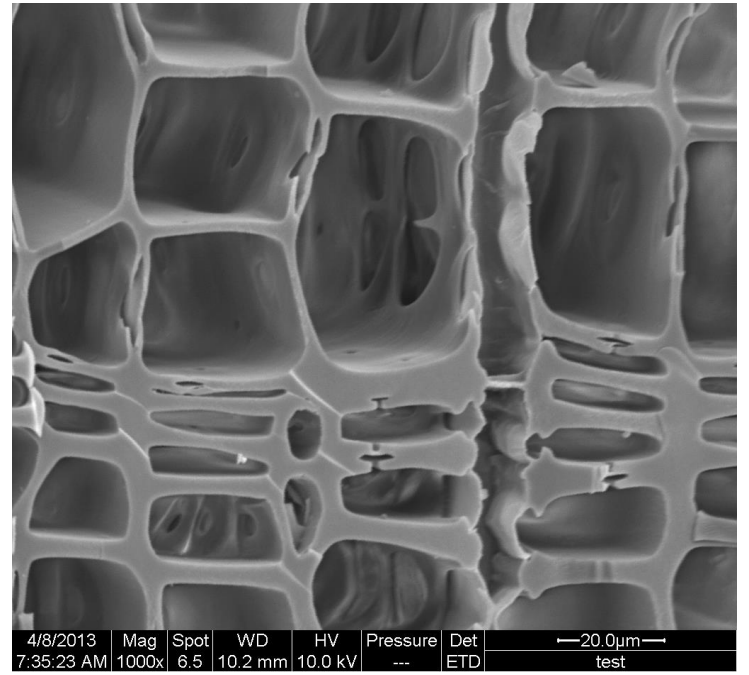


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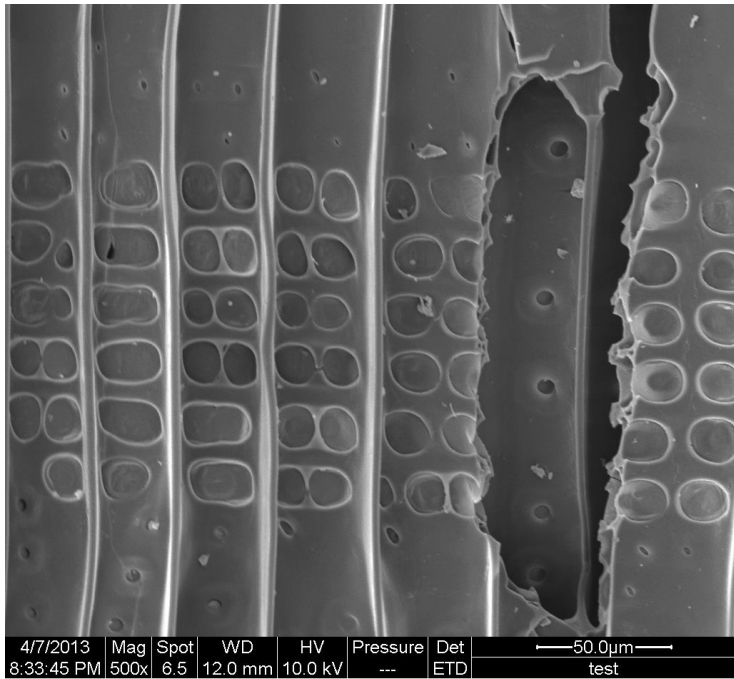
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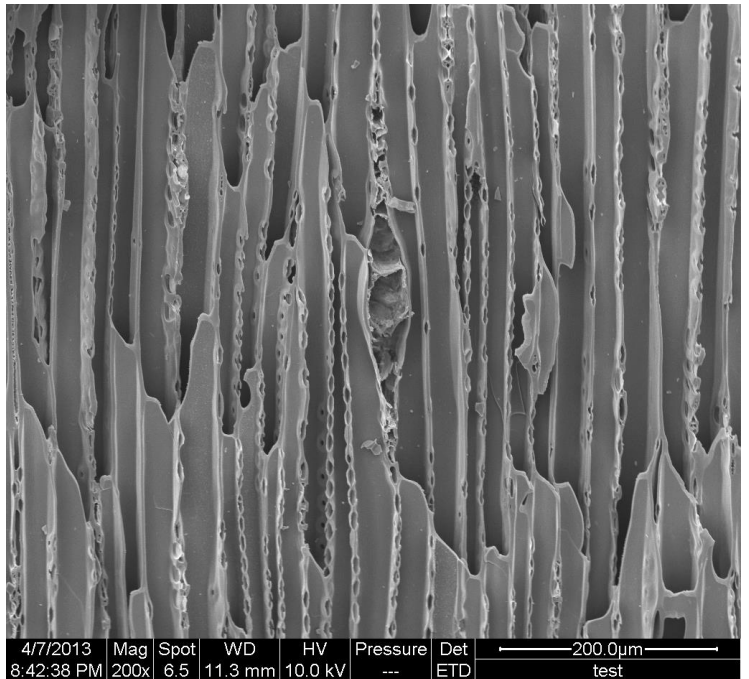
Cross-section magnified 50 times



Cross-section magnified 500 times

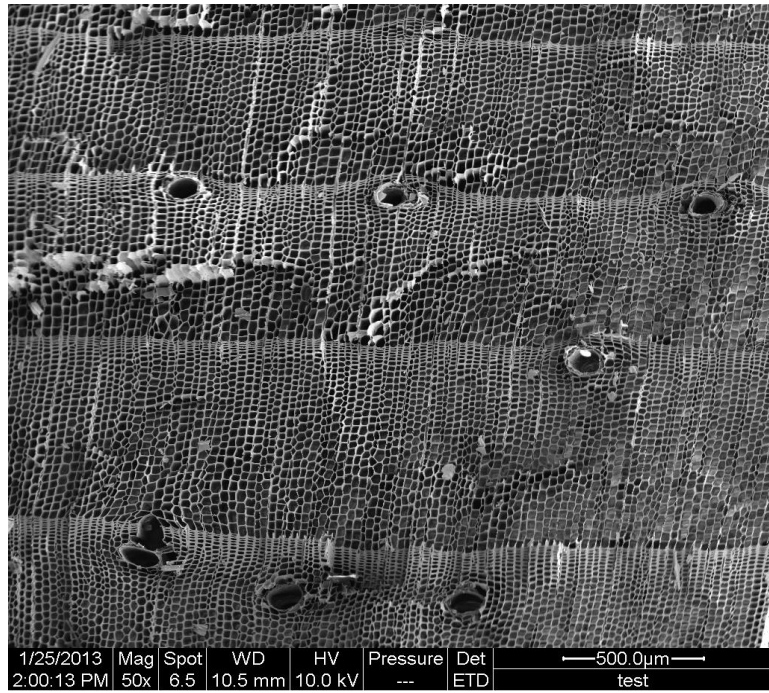


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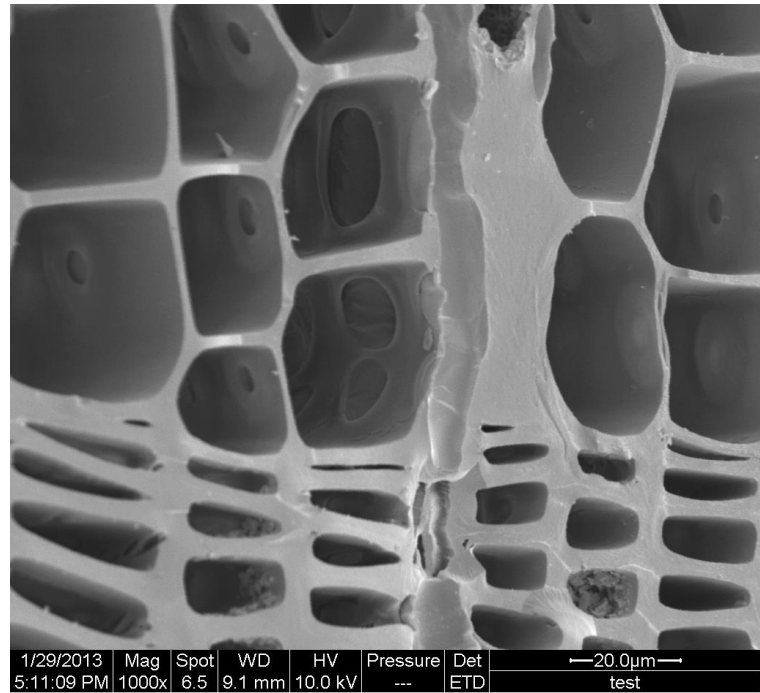


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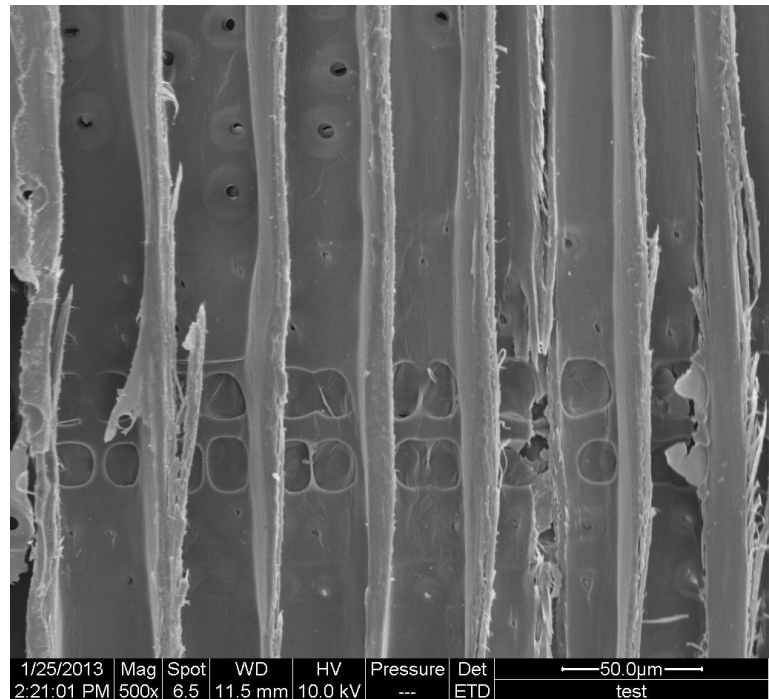
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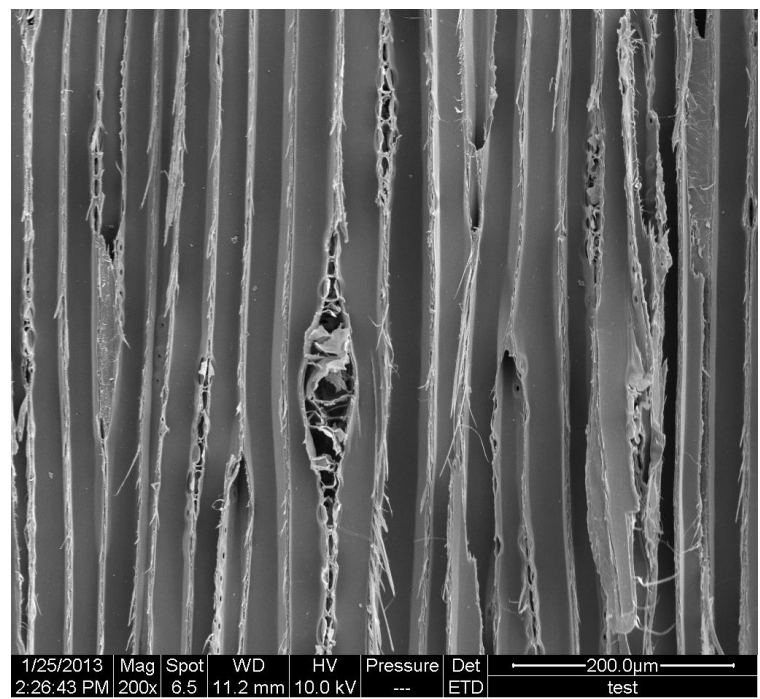
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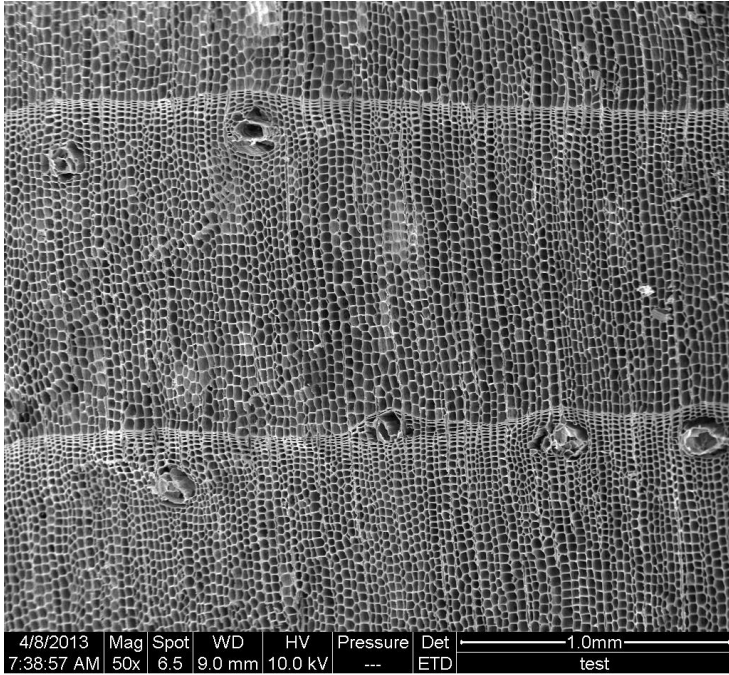


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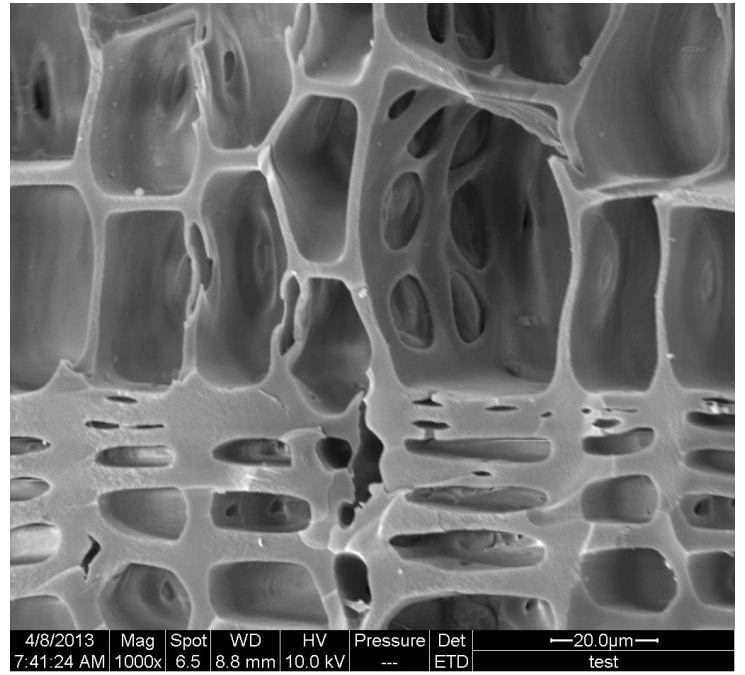


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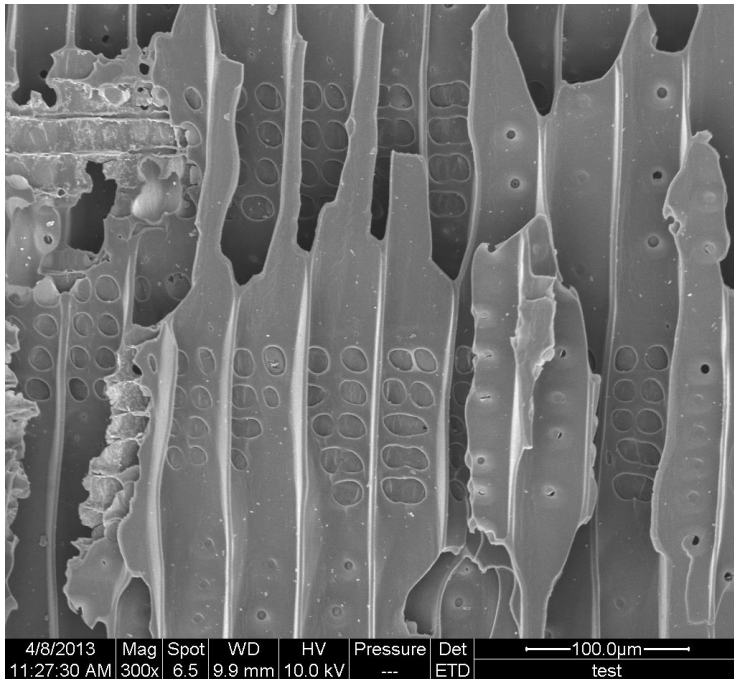
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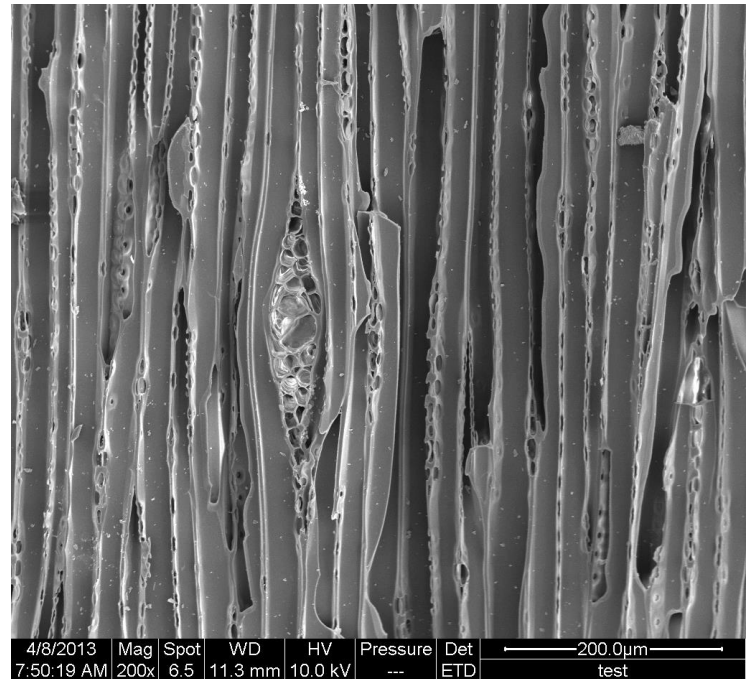
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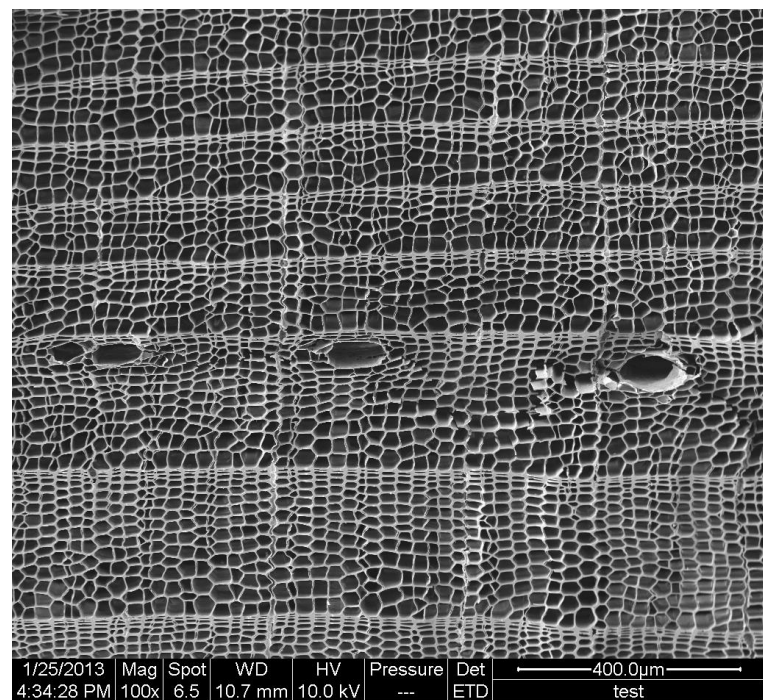


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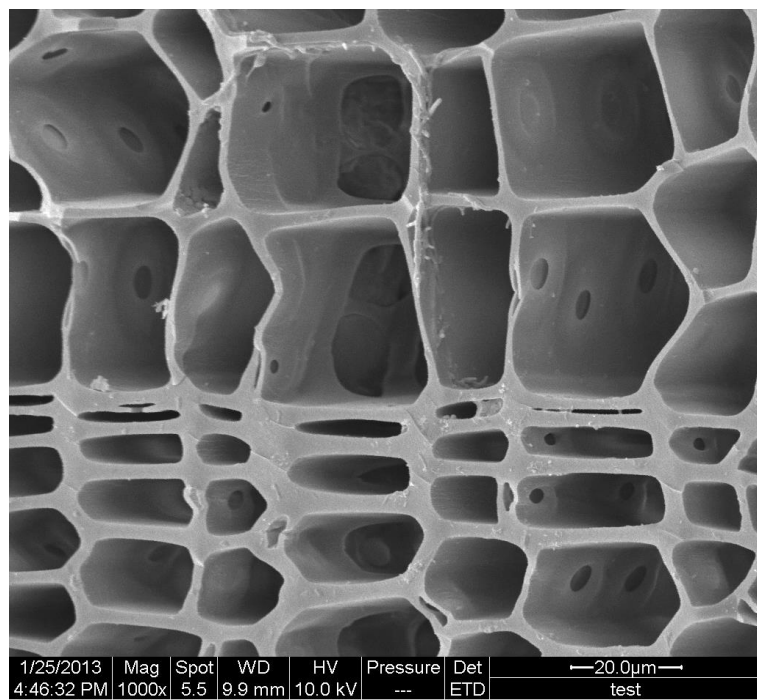


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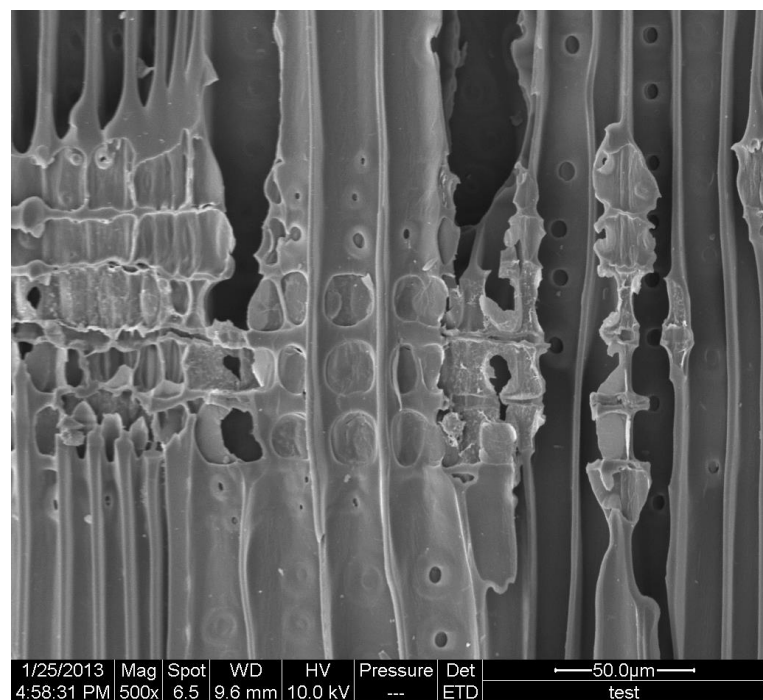
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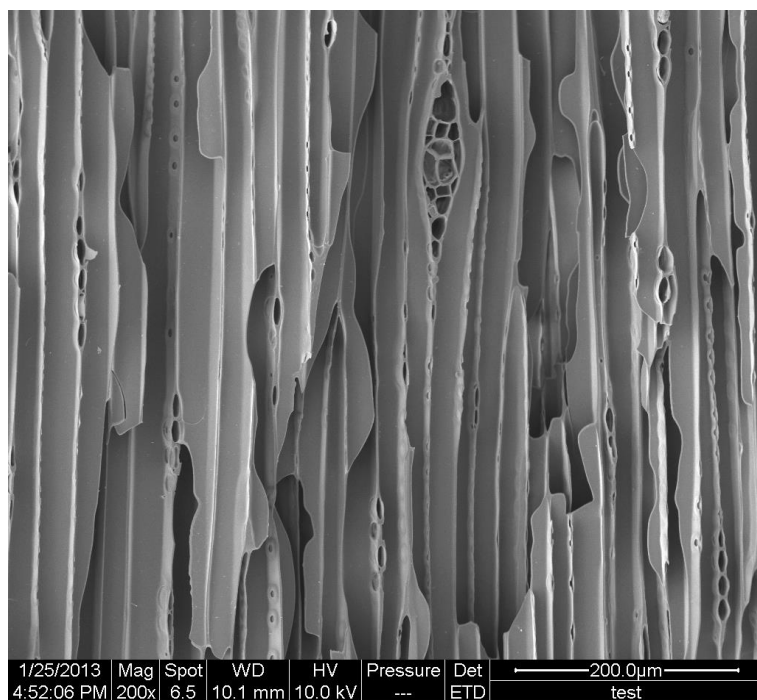
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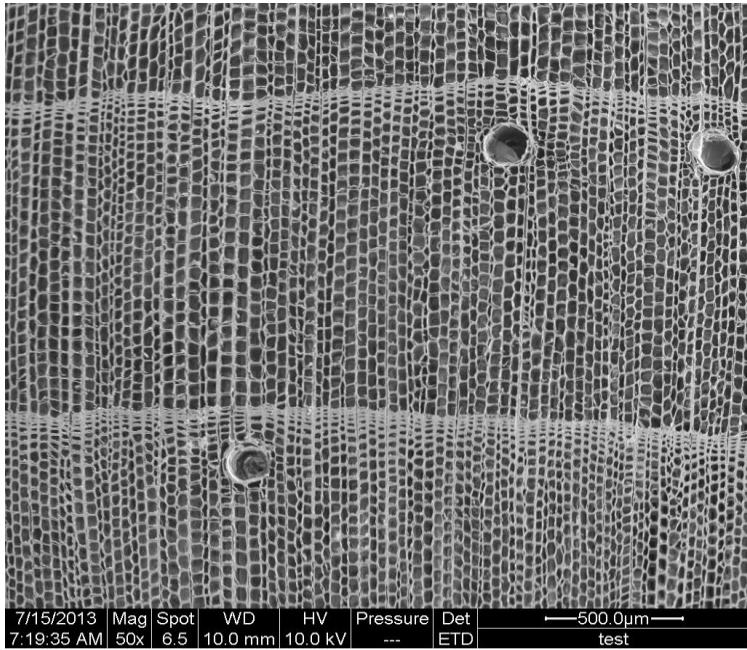


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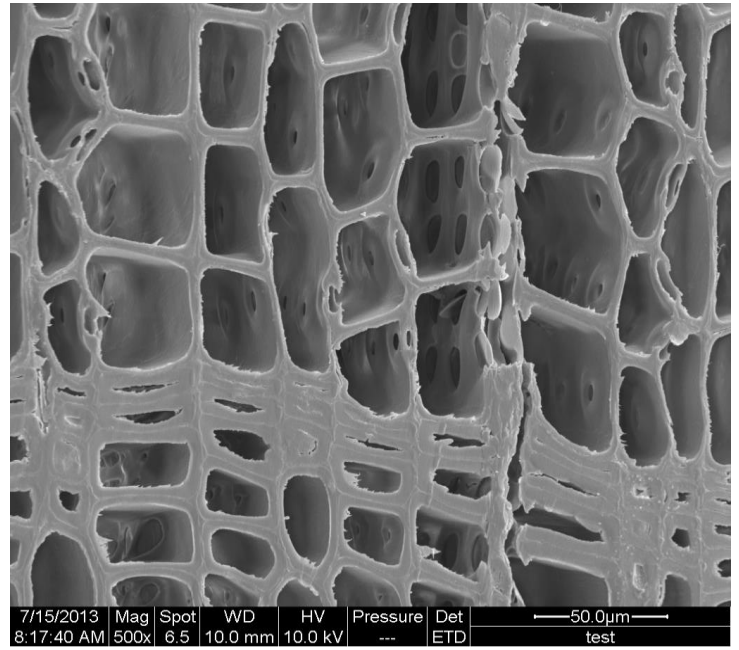


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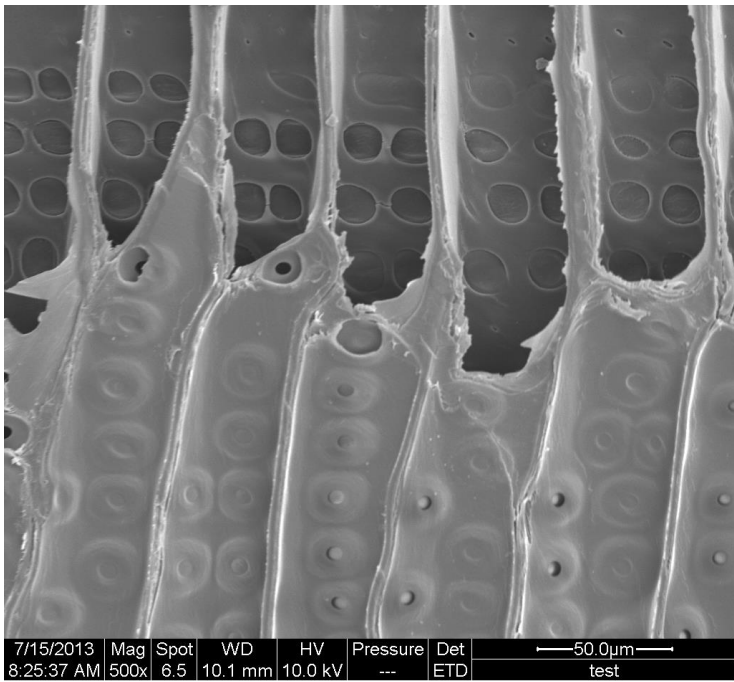
Figure S1 (continued) for carbonized log No. CBSXB-14



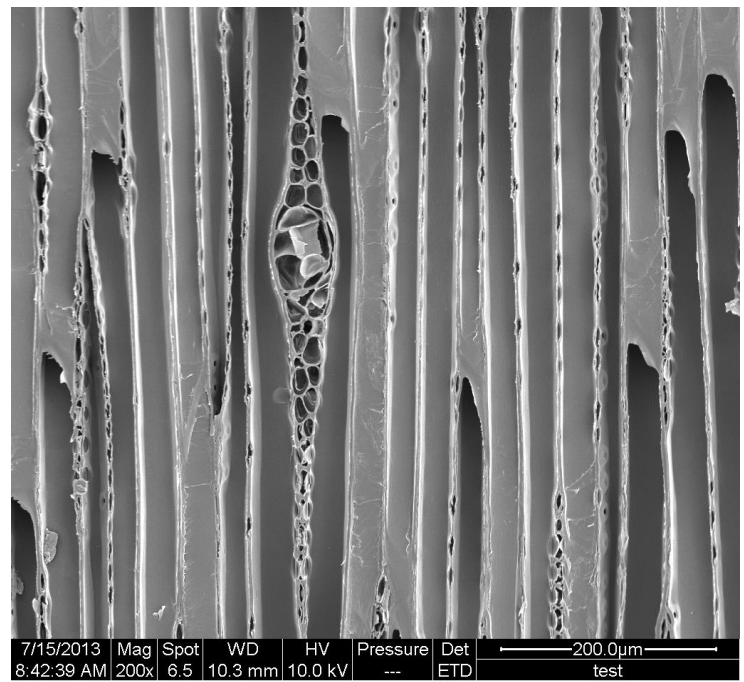
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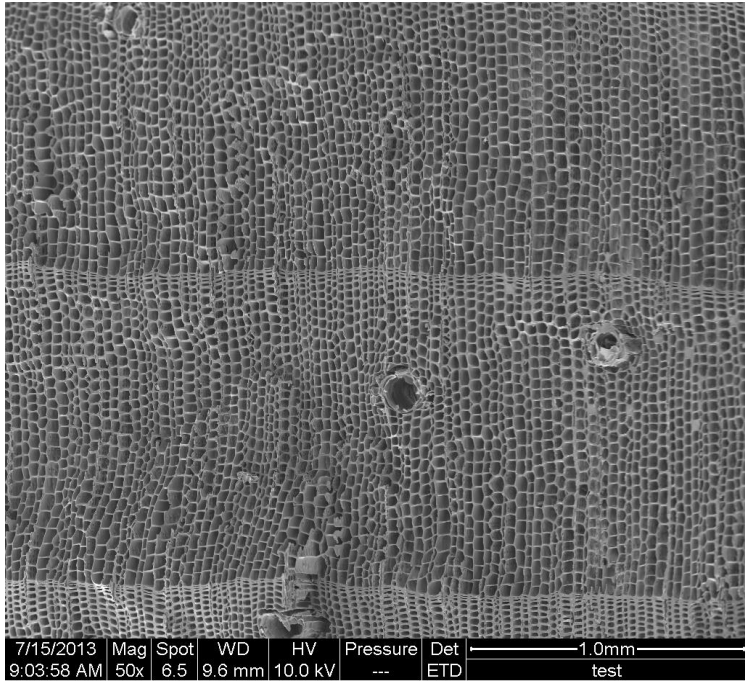


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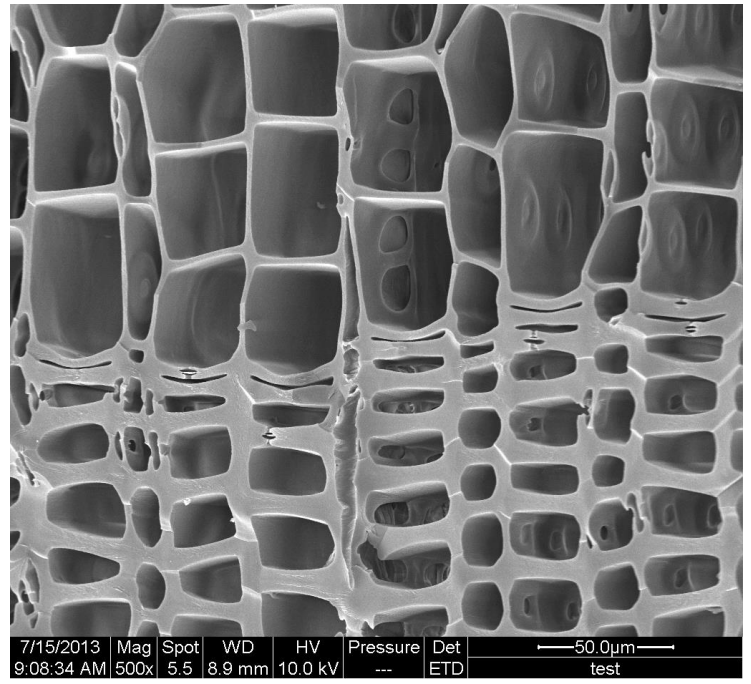


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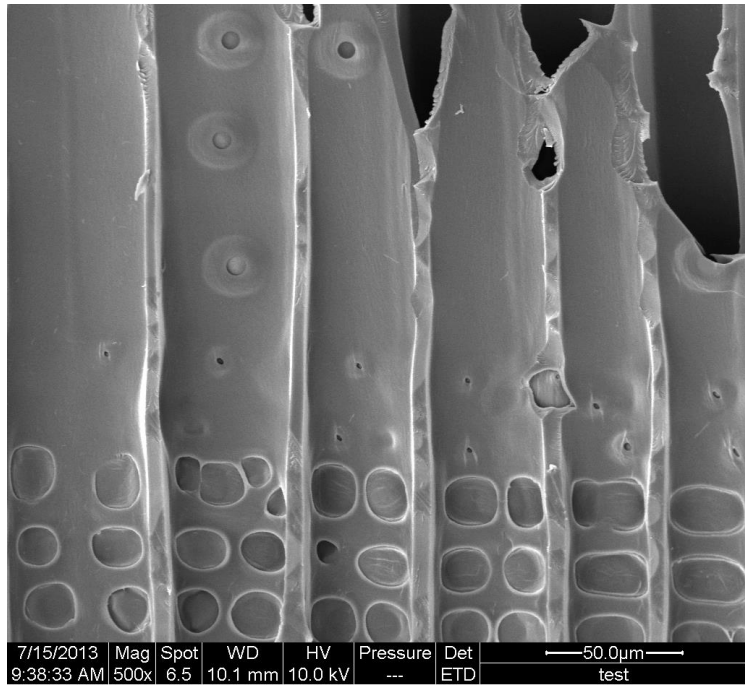
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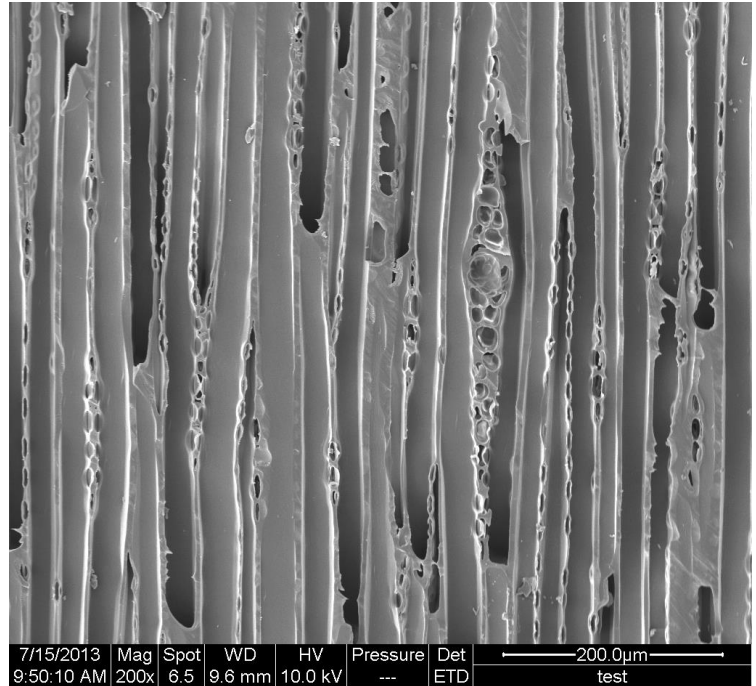
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Cross-section magnified 500 times

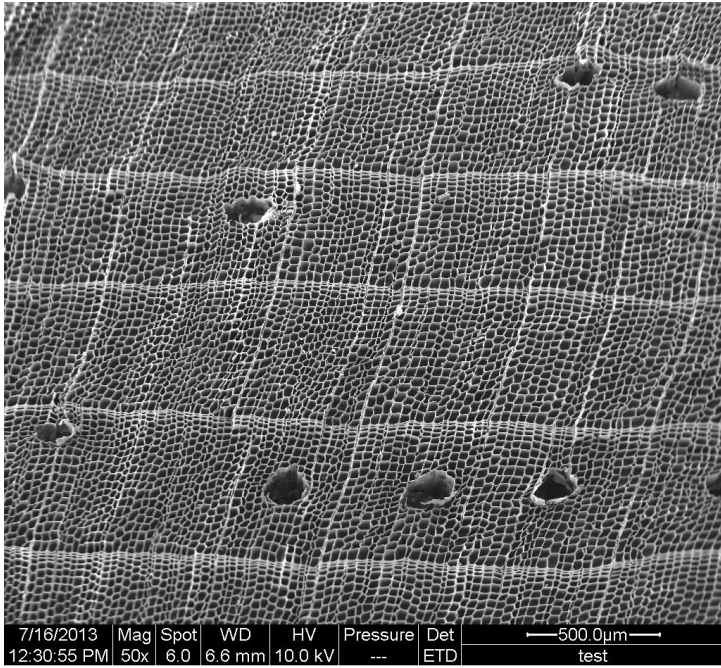


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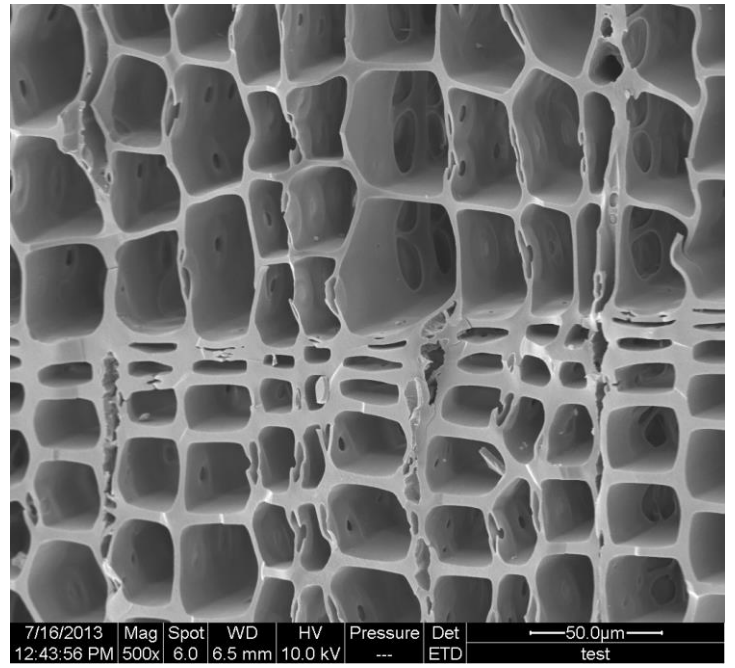


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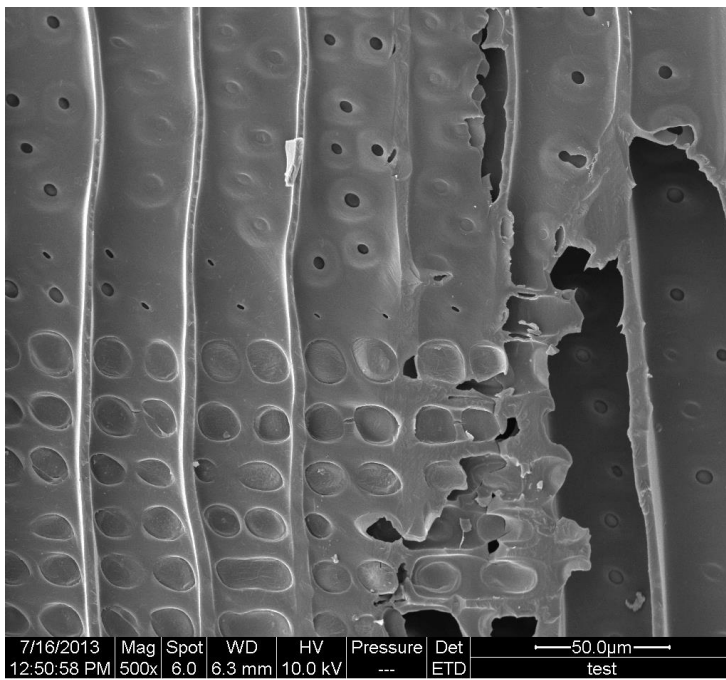
Figure S1 (continued) for carbonized log No. CBSXB-17



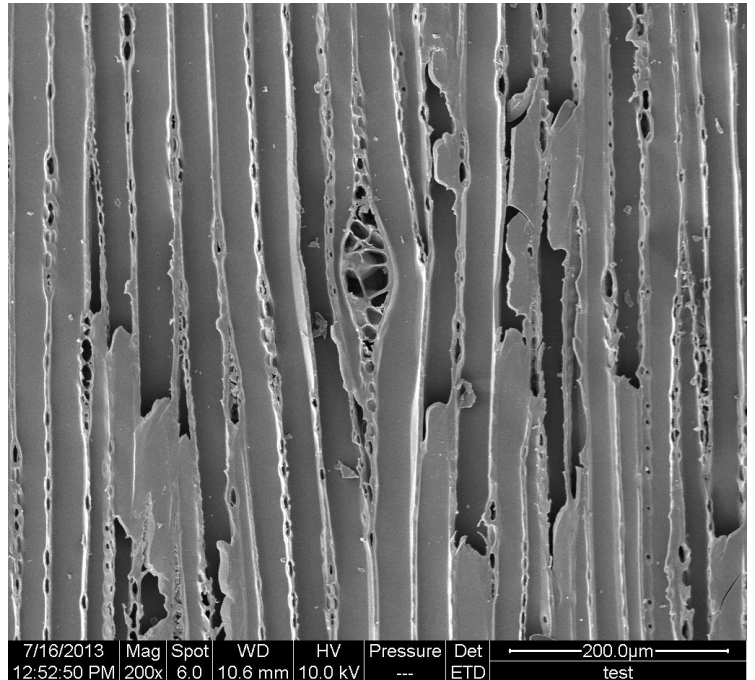
Cross-section magnified 50 times



Cross-section magnified 500 times

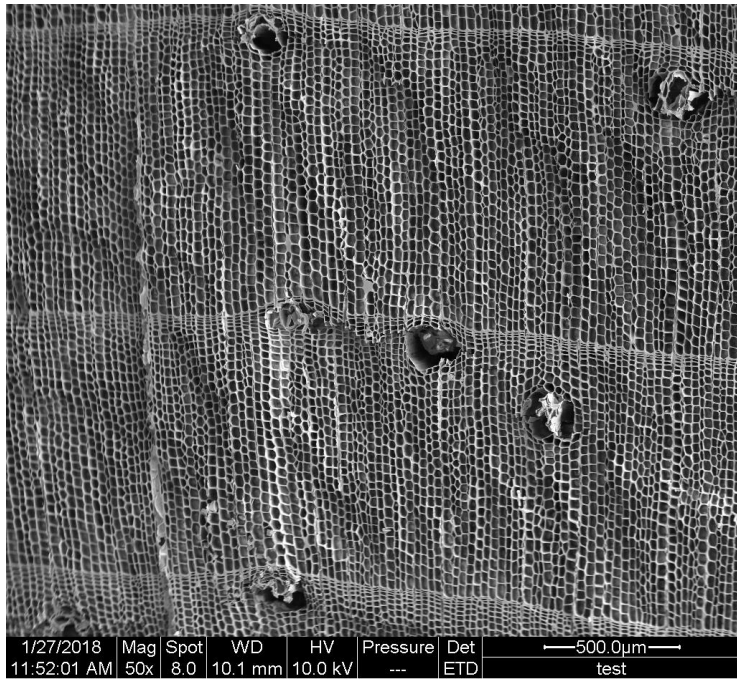


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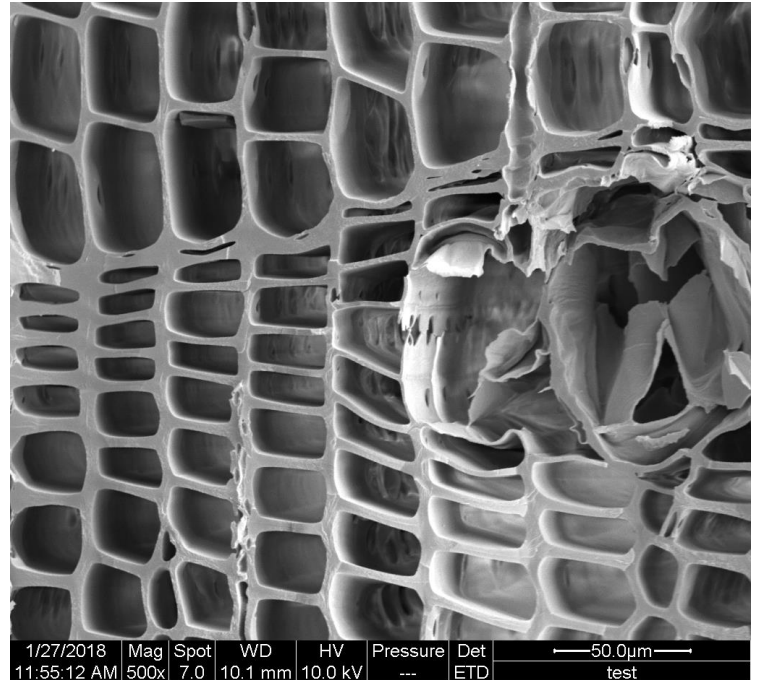


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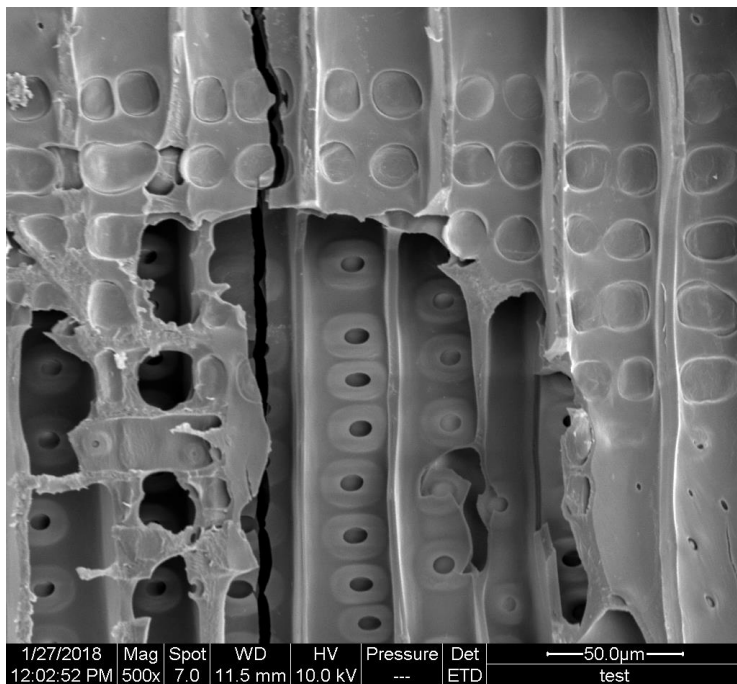
Figure S1 (continued) for carbonized log No. CBSXB-21



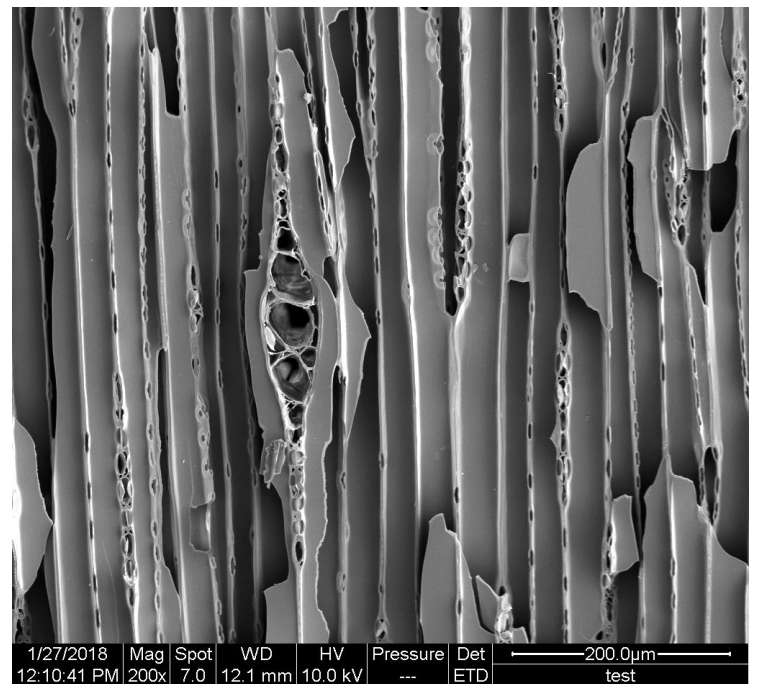
Cross-section magnified 50 times



Cross-section magnified 500 times



Radial-section magnified 500 times



Tangential-section magnified 200 times

Figure S1 (continued) for carbonized log No. CBSXB-26

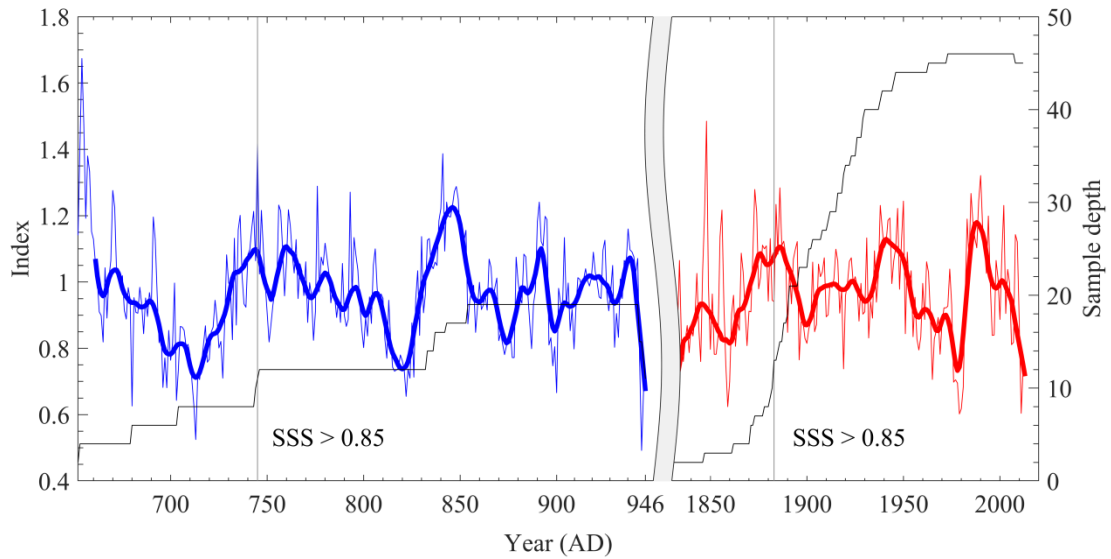


Figure S2. Standardized (STD) chronologies of carbonized trees (blue line) and modern trees (red line). The carbonized tree chronology spanned 295 years (652-946 AD) prior to the Millennium Eruption. Modern trees spanned 183 years (1830-2012 AD). Both chronologies are shown with a 13-year moving average filter (heavy lines) and sample depth (right y-axis).

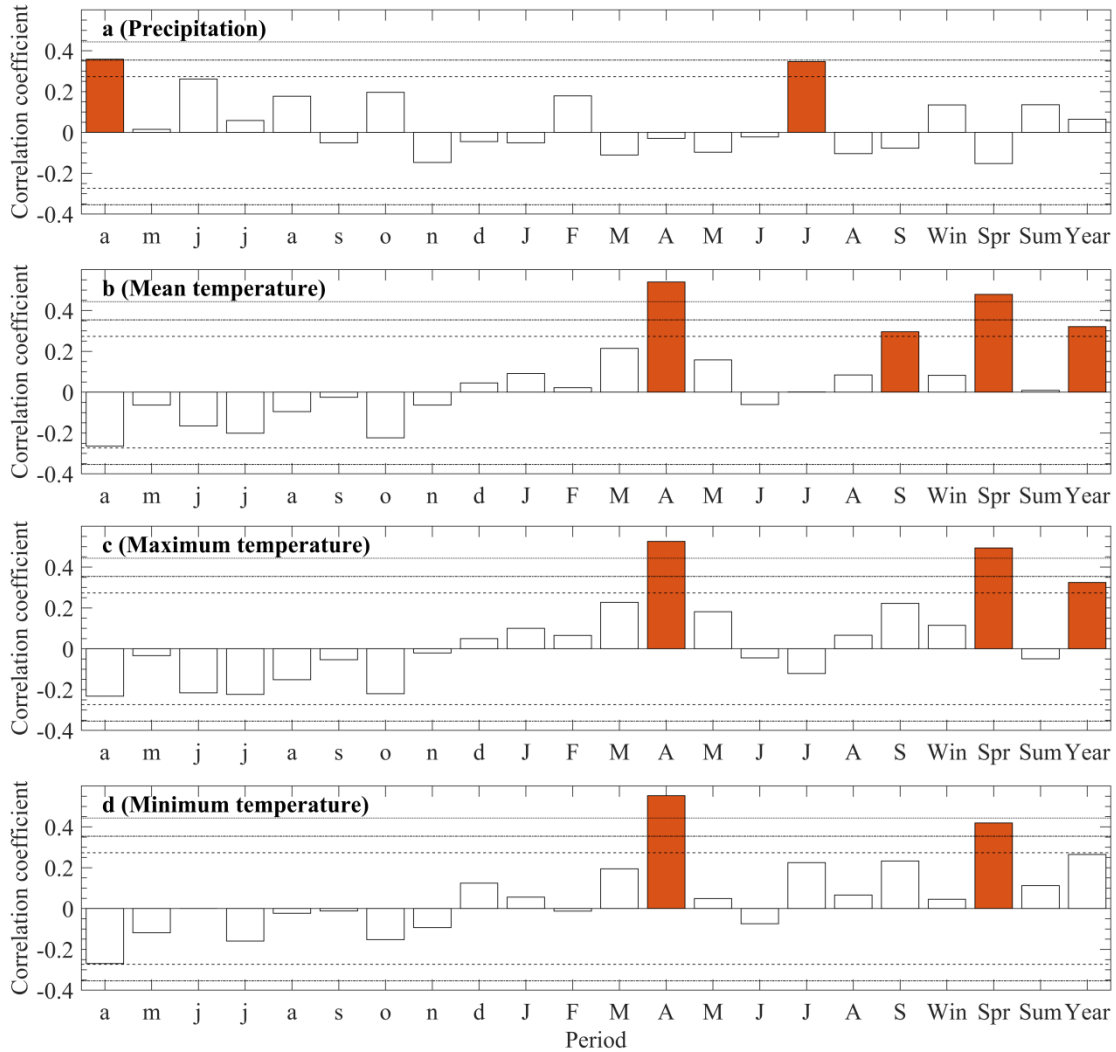


Figure S3. Pearson correlation coefficient between the first-order difference series of STD tree-ring chronology and monthly, seasonal and annual (a) precipitation, (b) mean temperature, (c) maximum temperature, and (d) minimum temperature during 1961-2012. Lowercase and uppercase letter on x axis indicate the months of the previous and current year, respectively. The horizontal dotted, dash-dotted, and dashed lines represent significance levels of 0.001, 0.01, and 0.05, respectively. Bars with significant correlation were filled with colour.

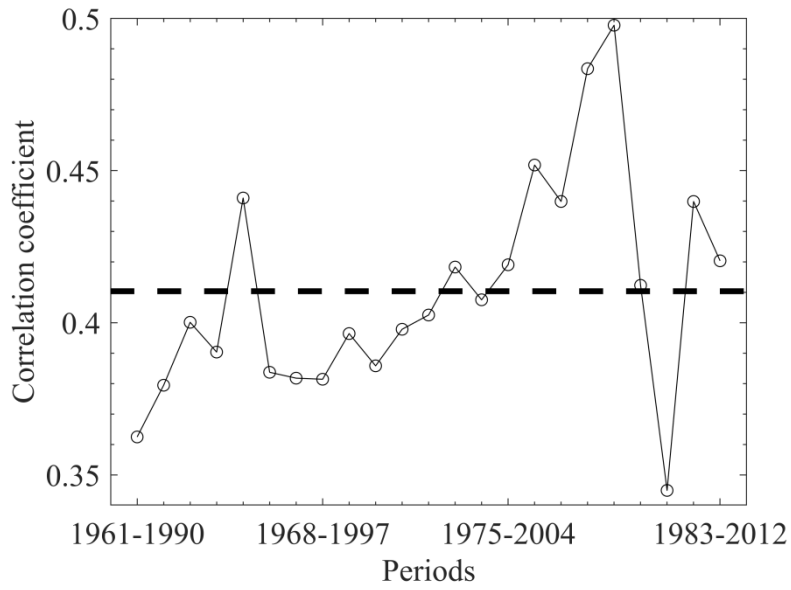


Figure S4. Thirty-year moving correlation coefficient between the STD chronology and April mean temperature during 1961-2012 in the Changbai Mt. The thick dash line shows the average of the moving correlation coefficient.

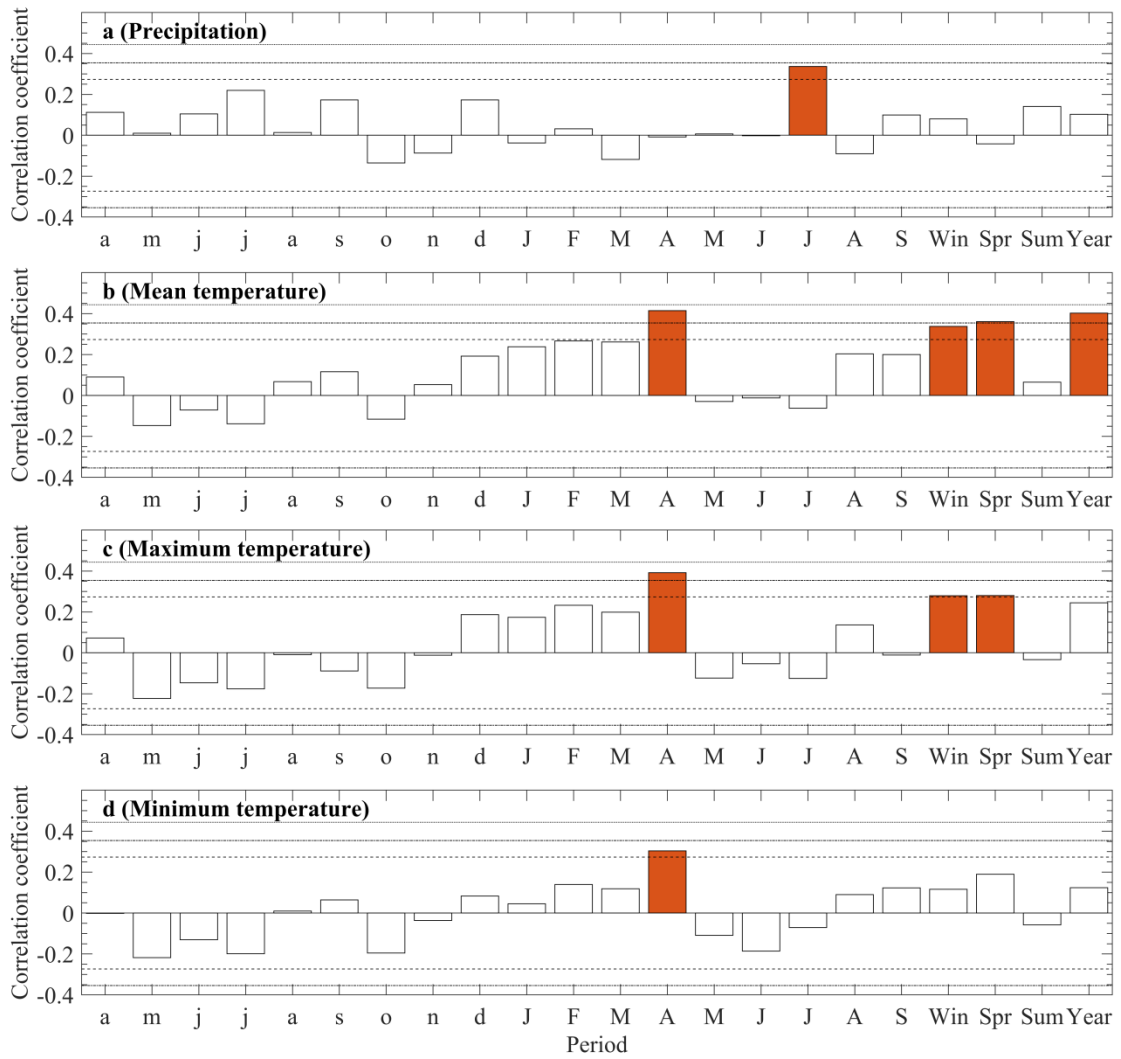


Figure S5. Same as Figure 2, but for the detrending method of negative exponential curves.

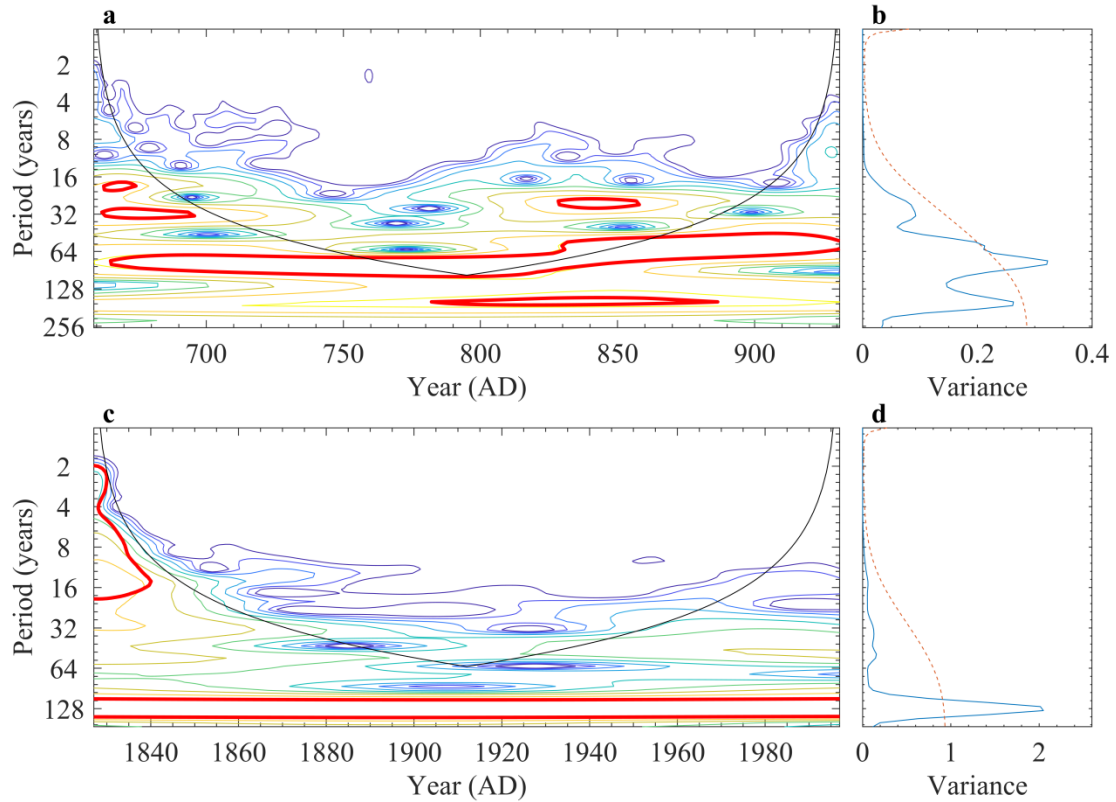


Figure S6. (a, c) Wavelet power spectrum of the 30-year moving standard deviations of reconstructed April temperature from (a) carbonized and (c) modern trees. The power has been scaled by the global wavelet spectrum. Bold red contour is the 95% confidence level using a red-noise (autoregressive lag1) background spectrum. (b, d) The global wavelet power spectrum (light blue line) for the 30-year moving standard deviations of (b) carbonized trees- and (d) modern trees-based temperature reconstructions. Dashed lines represent a significance level of 0.05.

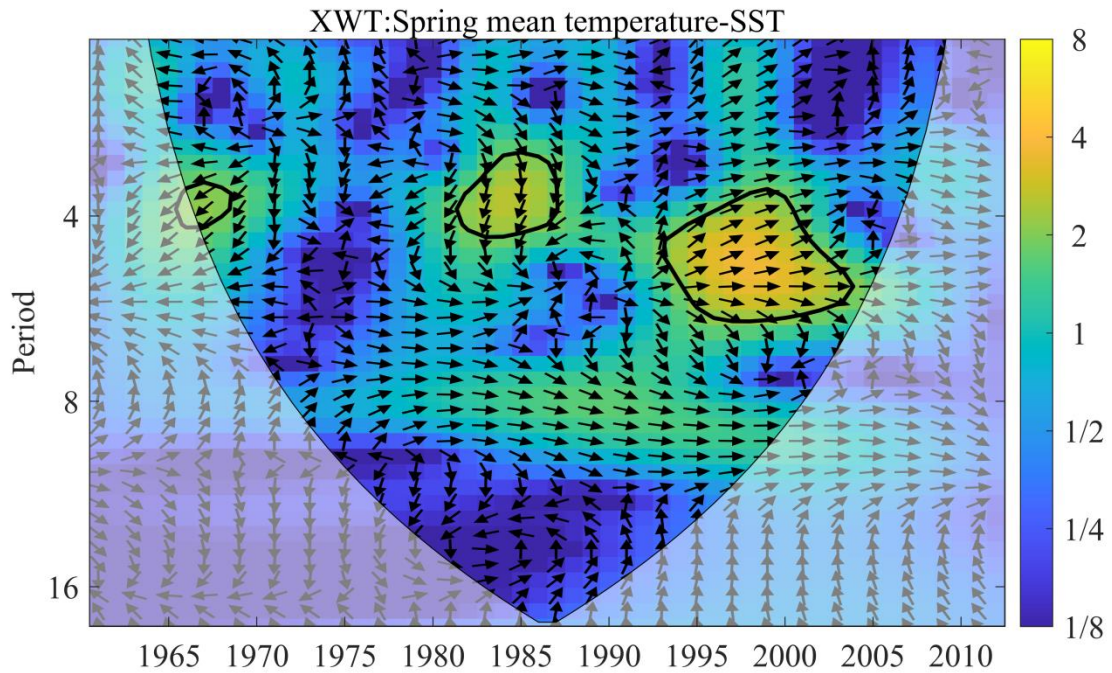


Figure S7. Cross wavelet transform of the spring mean air temperature of Changbai Mountain during 1961-2012 and mean sea surface temperature (SST) of Eastern Tropical Pacific (0 to 10° South and 90° West to 80° West) time series (<https://psl.noaa.gov/data/timeseries/monthly/NINO12/>). The 5% significance level against red noise is shown as a thick contour. The relative phase relationship is shown as arrows (Grinsted et al., 2004; <https://doi.org/10.5194/npg-11-561-2004>).