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Report on the Ph.D. thesis “Study of fossil wood by modern analytical methods: case studies” by RNDr. Petra Matysova

The Ph.D. thesis addresses the detailed identification and localization of mineral phases in fossil wood by means of complementary analytical methods of microscopy and spectrometry, inductively coupled plasma mass spectrometry and X-ray diffraction. Applying these methods to a multitude of well-classified morphotaxa from diverse world localities with different palaeoenvironments, the Petra Matysova succeeded to contribute to an advanced understanding of the multi-stage process of permineralization with the focus on silicification. The process of fossil wood formation is subject of a long lasting and controversial debate until today. Therefore, an advanced and extended data base is crucial for an improvement of the concept of permineralization.

From the beginning of her work in 2004, Petra Matysova recognized the potential of instrumental analysis to supplement conventional petrographical analysis on thin sections. Consequently, the thesis includes a compilation of eligible methods provided with comprehensive publication citations, partly with a short description of the method, the requisite sample preparation and the results to be expected. One great merit of the thesis is the competent evaluation of corresponding publications with respect to the appropriate effort of the analytical method(s) and (if published) the linkage of thus gathered results to the taphonomic background, i.e. botanical, environmental, sedimentological, and geological conditions.

The introduction section of the thesis provides a relevant overview of issues decisive for taphonomic background description with regard to paleobotany, mineralogy and petrography of silica, silicification and other types of fossilization. A separate detailed section deals with different environmental settings with

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special regard to silicification. The subsequent section explains artificial silicification experiments published during the last decades and evaluates relationships and differences.

In conclusion, main aims of the thesis are defined. The issues (i), (ii), (iv) arise as a logical consequence. Dealing exclusively with cathodoluminescence, topic (iii) could be covered by (i). Topics (v), and (vi) are focused on particular questions thus serving as special examples. Basing on that outline, Petra Matysova organized the selection of the fossil specimen to be analyzed and the methods to be applied which proves her complete comprehension and excellent organizational skills. The obtained experimental basis comprises a wealth of results obtained from around 100 samples originating from 8 localities in the world. The results are clearly represented and well-discussed in 5 peer-reviewed publications. The thoroughly accomplished interpretation of the results is critically discussed in the context of the data and conclusions of a large and almost completely referenced array of international literature. The relevance of the contributions to further investigations on fossil wood, to the current understanding and follow-up discussions of permineralization pathways is obvious and confirmed by the number of citations so far. The conclusions section of the thesis provides a sound summary of the results thus answering the questions put by the main aims of the thesis. I highlight the clear statement of diagnostic CL signs applicable to distinguish specific conditions of wood silicification as an important scientific contribution.

Publications and thesis are written in good style and language, coherent and a pleasure to read. The thesis shows the author's ability of properly explaining and linking palaeobotanical, mineralogical and geological subjects with respect to fossil wood. In doing so, the repeated listing of questions derived from individual subsections is a very helpful and convincing methodological instrument. Comprehensible explanations and the logical structure contribute to the high pedagogical value of the thesis. I emphasize the addition of two artistic reconstructions of different silicification scenarios in this context.

The abstract corresponds to the thesis; and if its last sentence promises quite much then the proper title relativizes by introducing the term "case studies" thus announcing the thesis as a basis and inspiration for further studies. Last but not the least, Petra's Fossilization Recipe gets the "petrified wood scientific community" back on the ground of facts, but also shows how close this subject is to her mind and heart, respectively.

I would welcome her comments on the following points:

- Regarding sample preparation:
Preparation of thin sections and subsequent analysis by means of the petrographic microscope is a work-routine in geology and paleontology. However, fractured samples are not used occasional but preferred for SEM studies. This is not reasonable for a material scientist because of the benefit of using backscattered electrons for imaging (BSE) or diffraction (EBSD) on polished sections?
Otherwise, you mention the use of polished section for XRD (powder diffraction?)...

- X-ray spectroscopy is a common tool for elemental analysis. X-rays can be excited by an electron beam or radiation of appropriate energy. The latter is indicated as X-ray fluorescence and there are pretty handy devices on the market. How do you estimate it's advantages and disadvantages?
- How would you rank the following methods - optical microscopy, Raman microscopy, and cathodoluminescence in scanning electron microscopy, synchrotron micro-tomography, and TEM - according to their spatial resolution with respect to limitations by wave length, interaction volume or detector pixel size?
- One of your important conclusions is that the occurrence of moganite in fossil wood is linked with a volcanoclastic influence during silicification. However, a large amount of moganite is found in cherts from arid, alkaline environments; absence of moganite in weathered and hydrothermally altered silica samples is stated by Heaney & Post. How does this match?
- The deposition of polymeric silicic acids via formation of hydrogen bonds between silanol groups and polysaccharides in the cell wall is well-recognized and only recently substantiated by studies which clearly identified the hemicellulose callose as the molecular template for biological silicification. Lignin as the third main component of secondary cell walls interferes the deposition by hydrophobicity and decay resistance. Do you see any chance to deduce compositional variations of the original polysaccharide/lignin ratio of fossil wood and to link it with the actual silicification pathway?

The thesis brings a considerable volume of original mineralogical data linked to the "extended" taphonomic background of fossil wood from numeral localities in the world. The approach to distinguish alluvial and volcanic modes of wood silicification by CL signature is emphasized as new and beneficial. The thesis clearly demonstrates Petra Matysova's ability to perform sovereign and original scientific research on a highly advanced level.

To my great pleasure I recommend RNDr. Petra Matysova to be rewarded the PhD degree by Charles University in Prague.

Chemnitz, 11th August 2016

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