Petrified Wood as a Paleontological Artifact, a Museum Object, Stone-Cutting Raw Materials in the Collections of Museum of Karst and Speleology of the Mining Institute of the Ural Branch of the Russian Academy of Sciences

D V Naumkin

Perm Federal Research Center of Ural Branch of Russian Academy of Science, 614007 Perm, Russia

E-mail: calliope28@mail.ru

Abstract. The article tells about the collection of fossil mineralized wood kept in the Museum of Karst and Speleology of the Mining Institute of the Ural Branch of the Russian Academy of Sciences. It was formed from 2004 to 2020. The collection includes specimens of mineralized woods from eleven localities (five of them are located in the Perm Krai) belonging to four geological systems - Permian, Triassic, Jurassic and Paleogene. Despite the small volume (35 storage units), our collection is quite representative both geographically and chronologically.

1. Introduction
Fossilized wood is often found in the Middle Perm deposits of the Volga-Ural region that was formed as the result of the removal to the plain of the products of the destruction of complexes of various rocks of the ancient Ural Mountains [1]. Sedimentation occurred in a wide range of facies – from marine to continental. On the territory of the Middle Urals within Perm Krai, terrigenous rocks of the middle part of Perm system predominate in its southwestern part, being replaced to the east by marine and lagoon sediments of the lower part of the Perm system.

The paleontological collection of the Museum of Karst and Speleology of the Mining Institute (Kungur, Perm Krai), which is currently dominated by Paleozoic marine invertebrates [2; 3], also contains paleobotanical material [4], which is still significantly inferior in quantity to fossil marine biota. The collection samples of fossilized wood consist of less than a half of the total number of paleobotanical exhibits. Despite the small volume (35 items of storage), our collection is quite representative both geographically and chronologically.

2. Material and methods
The collection of petrified wood was collected between 2004 and 2020. The author of the article, his colleagues, as well as many strangers, whose names are indicated in the description of the collection, who donated randomly found samples, took part in its acquisition. When working in geological sections, traditional methods of field geology were used. Selected wood samples were subjected to minimal processing. A small part of them have undergone grinding. Sample dimensions (indicated below) are given in cm (height x length x width).
The systematic of fossil Paleozoic pycnoxylic woods is poorly developed. Apparently, all the listed samples belong to the formal genus *Dadoxylon sp.*, which can include wood from both true Conifers (Pinopsida) and Voynovsky – "Angara Kordaites" (Vojnovskyopsida), the systematic are given according to Prof., Dr. S. V. Naugolnykh [5]. Finds of such fossil wood are known in the famous places of the fossil biota of Perm [6]: Yezhovo (Ochersky district) and Kueda-Klyuchiki (Kueda district), as well as in other regions of the Urals and the Volga region.

3. Description of the collection

Within the boundaries of Kungur District, the closest and the most famous location of fossil wood is Markova Mountain, which stretches along the western outskirts of the countryside Mazunino [7]. Wood is not found in the section of the mountain. All our findings (2007, 4 copies) relate to the plowed upper part of the mountain. We did not find large samples there (the maximum length of fossilized wood fragments reaches 30 cm), although in the past, according to the literary data [7], farmers plowed whole stumps and large fragments of trunks with pycnoxylic wood there. The samples were light but, more often, dark brown in colour, replaced with quartz/silica, often covered with iron oxides (limonite). Cavities and cracks were made of small quartz crystals that form whole brushes or druses (figure 1 A).

A similar sample (a little bit larger than the copies from our collections on Markova Mountain) was presented to the museum in 2018 by a member of the Union of Artists of the Russian Federation, V. V. Gnatyuk. The sample originates from the vicinity of the village Krasny Yasy (Orda District, figure 1 B).

A series of samples (2007, five copies) comes from Kueda District, from a quarry near the village Dubovaya Gora (Oak Mountain) (8 km to the North from the location of fossil tetrapods, fish, insects and plants Kueda Klyuchiky). These samples of mineralized wood have a lighter colour than the specimens from Markova Mountain, without pronounced quartz mineralization, often with manganese dendrites and iron oxides (figure 1 C).

A sample of fossilized wood, buried in the proluvial deposits of Kokui Mountain section (the famous location of fossil plants and vertebrates) in the vicinity of Ocher, was received in 2011 from the Dr. N. V. Lavrova. A similar colour and texture sample from the vicinity of the countryside Tarlovka (Yelabuga District, Tatarstan) was presented in 2004 by L. I. Krapivin (figure 1 D).

In October 2020 (thanks to the invitation of the residents of the countryside Novoilinsky (Nytva District) A. A. and T. V. Kulikov), D. V. Naumkin, O. I. Osetrova and A.V. Krasikov visited a quarry which is located on its territory. There, in the thirty-meter thick alluvial-proluvial deposits, represented by sandstones, gravelites and conglomerates consisting of well-rounded pebbles, were found large (up to 1 m in length) fragments of trunks with pycnoxylic wood. The collected samples were mostly dark brown in colour. The substitution was performed with quartz/silica, the crystals of which formed brushes and druses on some samples, as well as calcite, which mainly replaced the core of the trunks (the size of the crystals is up to 1 cm in length). Sometimes such samples were found separately, without preserved outer layers (figure 1 E). Small fragments of bark replaced with calcite up to 1.5 cm thickness were also found there. The largest fragments of wood registered in the museum (a series of 8 samples) reached 0.5 m in length (figure 1 F).

Thus, in total, the collection contains samples of petrified wood from five territories of Perm Krai (Kungur, Orda, Kueda, Nytva and Ocher Districts). According to the literature resources, the petrified wood is found and known from at least ten administrative districts of the region.

Samples that were found in neighboring regions and had a similar late Paleozoic (early Perm, or more precisely, Kungur age - wood from the location Mezhevaya from Krasnoufimsk District, Sverdlovsk Region; and the middle Perm, Ufa and Kazan age - wood from the Volga Region and Orenburg Region) are mainly represented by single specimens. This is the sample mentioned above from Tarlovka, two samples – from Krasnoufimsk District (Mezhevaya, the gift of O. V. Abrosimova, figure 2 A) of Sverdlovsk Region, and three from Kzyladyr karst plateau (Kuvandyk District of Orenburg Region, the fees of Dr. O. I. Kadebskaya, 2015, figure 2 B-C). Krasnoufimsk and Kzyladyr samples are similar in
appearance; they are replaced by dark, almost black quartz with the presence of calcite and quartz crystals in the cavities. They are partly polished and look very attractive.

There are only four Mesozoic samples of mineralized wood in the collection. Three of them belong to the Triassic. The largest exhibit of the collection is a fragment of a trunk, presumably a coniferous tree from the famous Korkino coal mine in Chelyabinsk Region. The museum dimensions of the exhibit are 29x33x22 cm (height, length, width). The substitution is made with quartz and dolomite (figure 2 D). The age is late Triassic T₃r. The gift of Dr. S. S. Potapov (2005).

In 2019, O. I. Osetrova acquired very beautiful polished sections of the fossil tree Araucarioxylon sp. at the exhibition "Mineral Show" (Yekaterinburg), which is a constant source of replenishment of our museum fund. They have come from the vicinity of Ambilube (Diana Region, Northern Madagascar). The wood is replaced by coloured chalcedony (from white and blue to dark brown, figure 2 E). Age – early Triassic.

The only sample of the Jurassic age in the collection is a fragment of a branch 11 cm long, that was found near the station Sands of Moscow Region. The sample is carbonized, covered with the smallest quartz crystals and iron oxides (slightly). It was presented in 2017 by the collector V. G. Gorbenko (Moscow).

The youngest fragments of wood available in our collection belong to the Paleocene Pg₁t (initially, the Eocene age of these wood specimens was incorrectly indicated). A series of five samples was presented to the museum by the head of the school museum from Toliatti, E. K. Semenov (in 2006 and 2013). They are originated from a well-known location in the north of Syzran District of Samara Region, near the countryside Trubetchino. The samples are made of light grey chalcedony, the cavities, left by beetle larvae, are filled with small quartz crystals (figure 2 F). The species of these woods has not yet been established. It is known that they can belong to both coniferous (in particular, cypress – the formal genus Cupressinoxylon) and deciduous trees [8]. The largest and the most spectacular samples from this location are presented in P. V. Alabin’s Samara Museum of Local History [9].

4. Conclusion
Thus, our collection includes specimens of mineralized wood from eleven localities (five of them are located in Perm Krai) and four geological systems – Perm, Triassic, Jurassic and Paleogene ones. A small part of the collection – eight samples, was used to design a showcase display telling about the history of the development of life on the Earth.

The wide distribution of petrified wood in the Volga-Ural region makes it not only a paleontological artifact, but also a raw material for stone cutting. The town of Kungur and its environs have a long tradition of stone-cutting art. Along with gypsum and soapstone, petrified wood is used to make small stone-cutting products and jewelry. Despite the more modest color range (compared to the younger fossilized wood of Madagascar or the USA), products from the Ural Paleozoic petrified wood are known and in demand. Similar art items are also present in the collection of our museum.
Figure 1. Fossil wood samples. The collection of the Museum of Karst and Speleology (MKS) of the Mining Institute of Ural Branch of Russian Academy of Sciences. The formal genus *Dadoxylon sp.* Location.

A – Markova Mountain (Kungur District), MKS 133/1;3; B – Krasny Yasyl (Orda District), MKS 230/9; C – Oak Mountain (Kueda District), MKS 133/6;8; D – Tarlovka (Yelabuga District, Tatarstan), MKS 107; E-F – Nytva-I (Nytva District), MKS 241/1-3. Foto by Ya. V. Nakaryakova.
Figure 2. Fossil wood samples. The collection of the Museum of Karst and Speleology (MKS) of the Mining Institute of Ural Branch of Russian Academy of Sciences. A-D – the formal genus *Dadoxylon* sp.; E – the formal genus *Araucarioxylon* sp.; F – the formal genus *Cupressinoxylon* sp. Location:

A – Mezhevaya (Krasnoufimsk District, Sverdlovsk Region), MKS 236/8;8a; B-C – Kzyladyr karst plateau (Kuvandyk District, Orenburg Region), MKS 244/13; MKS 169; D – Korkino coal mine (Chelyabinsk Region), MKS 55; E – Ambilube (Diana Region, Northern Madagascar), MKS 232/18;18a; F – Trubetchino (Syzran District, Samara Region), MKS 58/1; MKS 167/3. Foto by Ya. V. Nakaryakova
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