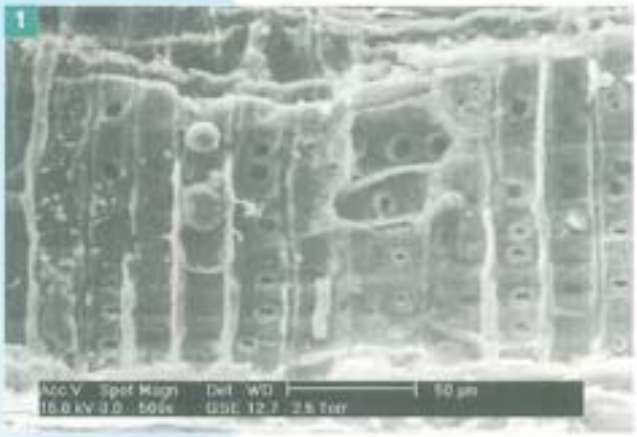
THE ENCHANTED FOREST

Millenary tree trunks, extraordinarily preserved by a layer of clay for millions of years. An important "living" fossil patrimony maintained on the hills of Umbria, which for centuries have kept secrets that probably can now be revealed.

Almost fifty trunks were buried under layers of clay for thousands of years at Dunarobba, a small centre of Avigliano Umbro, on the hills between Perugia and Terni, inside a vast area already known for the richness of its fossil deposits. It's an area that was born around the banks of a primitive group of lakes named "Lago Tiberino", where the humid climate favoured the growth of flourishing forests, such as the one of Dunarobba.

And it's definitely not a recent discovery. Already in 1600 it was the object of great interest for the 'Accademici dei Lincei', the Lincei Academicians, who included Federico Cesi, one of the founders of the Academy itself (1603), and Francesco Stelluti, who mentioned it in his "Trattato sul legno fossile minerale", (Treatise on mineral fossil wood) in 1637. It was then forgotten, only to be rediscovered in 1986 during the excavation activities carried out by a local furnace company. And once again people started talking about this fossil patrimony, rare not so much for its age or for the number of specimens, but for the unpredictable state of preservation of the remains, as demonstrated by the vertical position of the trunks and by the non-petrification of the wood that still seams freshly cut. The reason may surely be attributed to the particular ground poor of mineralising salts and anaerobic bacteria, and most of all to the clay that has buried the trucks for two million years. In fact, the clay has kept the trunks in a "mummified" state, leaving the wood in unaltered conditions, and allowing it to still move and react to the environment's climatic variations.

Practically, the isolating action of the clay layer avoided those mineralisation and decomposition processes that started when the trunks were directly exposed to atmospheric agents and rain.



Photos of some fossil wood samples taken using a Scanning Electron Microscope in the Mapei R&D Laboratory of Milan:
1. Longitudinal section of the fossil wood in the upper cortical area; the interlacing of micro-canals typical of vegetable structures is clearly visible.
2. Close-up of the cortical area; the crushed cells near the bark are evident.
3. Central section of the fossil wood; the (hexagonal) cells are well conserved, as if the sample was still "fresh".
4. Close-up of the wood's cell.

The action of the pouring rain combined with the wind and sudden temperature changes damages the wood's cortical part, which, after losing its vital substance, breaks away from the trunk and becomes sawdust. The process is accelerated by the attacks of birds and insects, such as the "Xylocopa Violacea", that are attracted by the plants. For this reason, "hut" shaped covers were prepared for immediate protection.

Laboratory analysis
The palaeontologist studies carried out on the clay and on the entire surrounding environment, along with the interdisciplinary contribution of the Universities of Perugia, Padova, L'Aquila and Viterbo, has lead to important conclusions. First of all, it was probably a forest of trees very similar to modern day sequoias, of the Taxodiaceae family, that were already thousands of years old when buried. Furthermore, the pollen analysis revealed that the forest probably dates back to the Pleistocene period, approximately two million years ago, just about when the Italian peninsula and the primitive Apennine valleys were starting to form. The dendro-chronological tests reveal the presence of growth rings, which demonstrates that contrarily to what previously believed, in that period there was already an alternating climate, even though temperatures were colder with respect to modern times.

Mapei's intervention
The problem of the wood's conservation could not however be solved only with temporary operations of this type, and the Archaeological Superintendence for Umbria, the 'Instituto del Legno' (Wood Institute), and the University of Florence decided to find a definitive "technological" solution that would allow to leave the trunks outside. This is why in 1997 Mapei laboratory technicians, in particular from the division of Adhesives for Resilient

The pictures on this page show the trunks of the Dunarobba Fossil Forest and their protective shelters.

material, were contacted by the professor Stefano Berti of the University of Florence to find a product that could satisfy these requirements. Mapei thus started a series of tests on small samples of fossil wood to determine their physical-mechanical, dimensional and hygrometric behaviour as environmental conditions and humidity change. Of all the tests carried out, of fundamental importance were the "SEM" micro-photographs (scanning electron microscope): high definition enlargements of up to a hundred thousand times revealed that the wood cells, recognizable thanks to their hexagonal structures, are alive and that only their borders are atrophied due to mummification. The cellular part of the wood is intact, but its structure is "unbalanced": the core continues to assimilate water through direct contact with the mud, but it's not able to discharge it externally because the membrane is atrophied, while the cortical part assimilates humidity but is not capable of holding it, totally dispersing it into the environment. It's this impermeability between the two parts that causes the cracks and the breakaway of the bark. In all this time though, the clay did not avoid the crystallization of the wood's natural resin, which, after its transformation into "amber", lost its ability to penetrate the wood's fibres and to carry out its protective function. Consequently, it was necessary to create a compound with a natural resin behaviour, an impermeable barrier through which the wood could breath but that at the same time could be removed in case of necessity. Subsequently, mixtures based on natural binders were prepared, such as waxes, colophony (a

natural resin), colophony esters and synthetic derivatives in dilutions in natural solvents like terpenes and spirits. After six months of experimentation on small samples of original wood and tests on some conifers, species that are similar to modern sequoias that were not available since they are close to extinction, six different formulations were obtained; from these, the two that showed the greatest stability to changes in humidity and climate were chosen.

The current situation

Everything is now ready, though we are still waiting to solve bureaucratic problems regarding the site and to clarify the terms of the financing necessary to give the CNR and the consultant operators the possibility to verify the on-site effectiveness of the solutions. In the meantime, all the plants have been unburied and only three trunks are under exam: one has been left outside, another has been cut at ground level and a third is kept in a climatic chamber. In view of the new biogenetic technologies, lately someone even proposed cloning the samples of the fossil forest; though this news-item was then denied, it confirms the great interest regarding this enormous finding.

In any case, besides eventual scenarios regarding DNA, certainly the Dunarobba forest represents an important occasion of study, and the need of preserving the site as correctly as possible, without the risk of contaminating the findings' original condition, must not be taken lightly.