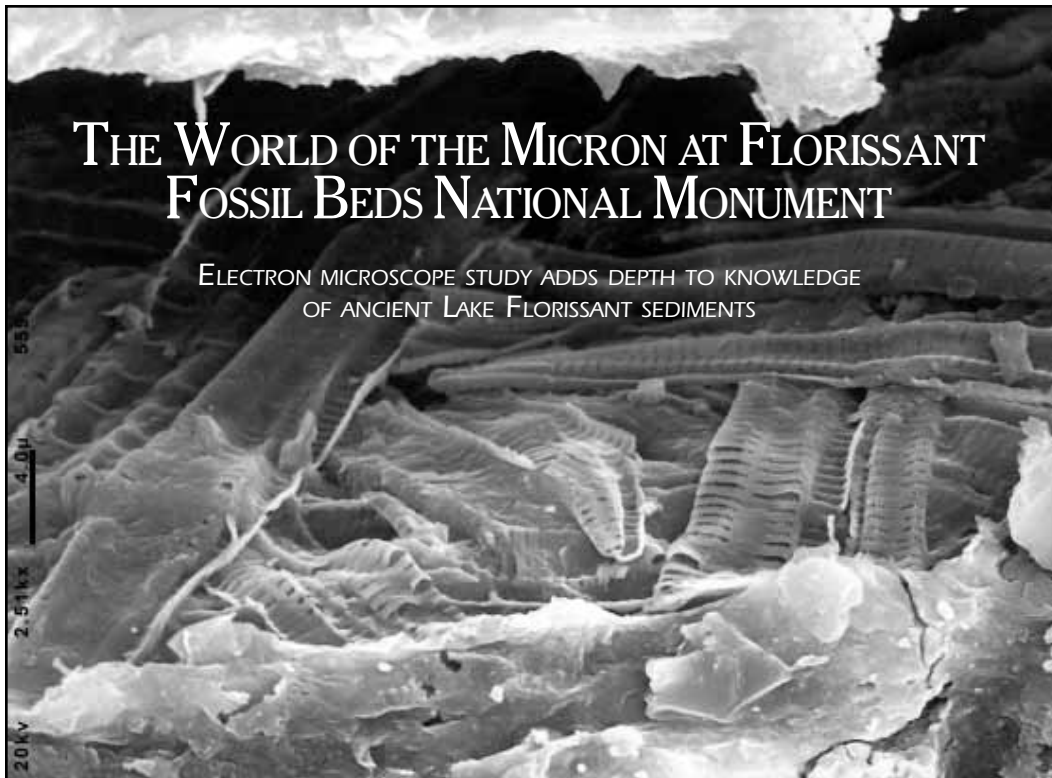


THE WORLD OF THE MICRON AT FLORISSANT FOSSIL BEDS NATIONAL MONUMENT

ELECTRON MICROSCOPE STUDY ADDS DEPTH TO KNOWLEDGE OF ANCIENT LAKE FLORISSANT SEDIMENTS



Note: Scale for all figures shown in microns (millionths of a meter).

Figure 1 (left). Scanning electron micrograph of a diatom mat.

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LYING IN THE SHADOW OF Pike's Peak in the Rocky Mountains of Colorado is an ancient lake bed containing remarkably preserved fossil remains of plants, leaves, and insects at Florissant Fossil Beds National Monument. Since the early 1870s, the delicate fossilized remains of conifers and many species of broad-leaved plants have been found entombed in the sediment layers along with a variety of insects such as beetles, flies, wasps, dragonflies, and butterflies. Although over 300 publications describe the fossil content of this unique geologic deposit, only a few discuss the details of the geological history of the lake that existed in the area during the later part of Eocene epoch 34-35 million years ago. During the summer of 1995, with support from the National Park Service, we began an intensive geological investigation to examine minute details of the sedimentology and paleontology of ancient Lake Florissant using the scanning electron microscope. We want to know what that happened 35 million years ago in Colorado.

An impressive feature of the lake deposits is the abundance of fine millimeter or less thick laminated sediments. Laminated sediments are common in many

lake deposits where they often show a seasonal alternation of deposition. Previous study of the laminations in the Florissant area (McLeroy and Anderson 1966) revealed that the deposit contained alternating fine layers of volcanic debris (pumice and ash), diatoms, and organic rich matter called sapropel. They indicated that the lake water was stratified and that these fine laminae recorded episodic events occurring with the seasons.

We undertook a detailed investigation of the laminated sediments in order to understand the ancient sedimentary processes during lake existence and what might have caused the alternating or episodic events recorded by the thinly layered sediment. Using a scanning electron microscope, we hoped to find microscopic clues to the source of sediment and how it was deposited in the lake basin. Viewing the lake deposits at the scale of the micron has revealed a world of sediment and fossil features never before seen in such detail from the Florissant beds. Presented here are our initial results of photos showing some of the features in the unexplored microscopic world of Lake Florissant. Our study is continuing; however, these initial results show that

there is another exciting aspect of the Florissant deposits in addition to previously described fossils.

Some very thin layers are composed entirely of the siliceous remains of diatoms belonging to a single species that bloomed in the lake water and accumulated on the bottom following a die-off. The diatom-rich layers indicated to McLeroy and Anderson (1966) clues of spring blooms

occurring during the time when winter and spring runoff supplied abundant nutrients to the lake for diatom growth. Our view at the micron level shows a mat of randomly scattered diatom fossils arranged like bodies on a battlefield after a terrible massacre (fig.1). A more accurate interpretation would be that the haphazard arrangement of fossils is proof of diatom blooming, mass dying, and fairly rapid burial. Another species of the diatom (fig. 2, page 20) also is found in other layers, but it does not form mats. These two diatom types may have lived and died under different ecological conditions. Our future study will try to determine if changes in the ancient lake conditions had an effect on the type of life living in the water.

Other alternating millimeter thick layers contain ostracode shells embedded in volcanic ash sediment. The bean-shaped shells of this crustacean (like a shrimp) sometimes are large enough to be seen with a hand lens but often escape recognition. However, their microscopic shells are very common in certain layers when viewed with scanning electron microscopy (SEM).

The structures of spores and wood are also revealed in the world of the micron of Lake Florissant. A valuable investiga-

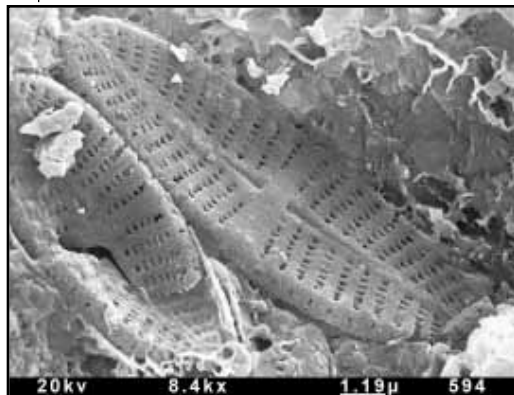


Figure 2 (above). SEM of the diatom type.

Figure 3 (right). SEM of redwood tree structures.

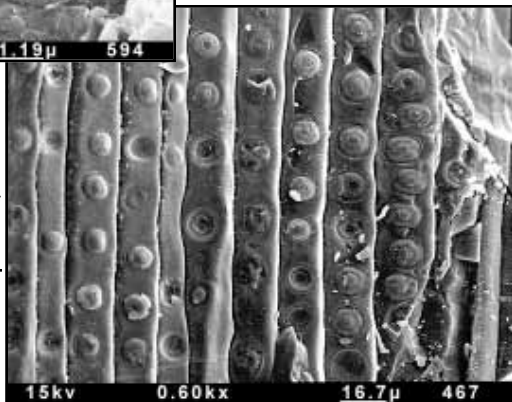


Figure 4 (right). SEM showing layers of volcanic ash and diatoms.

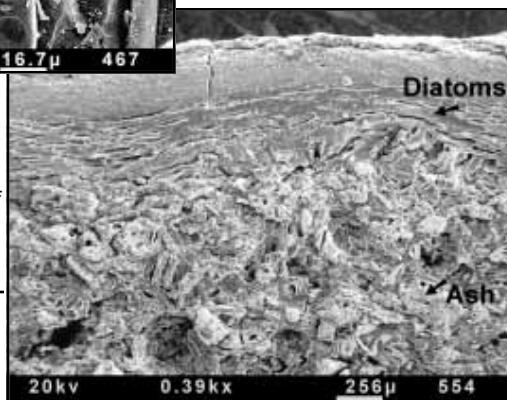
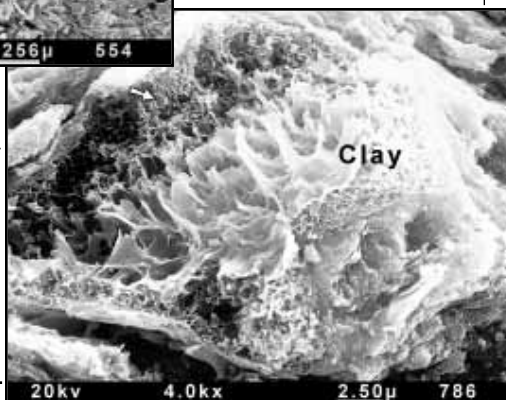


Figure 5 (right). SEM showing weathering of ash (arrow) to smectite clay. Notice how the clay appears to grow like a thin film on the solid volcanic grain.



tory procedure that supplements the scanning electron microscope and aids in identification of the chemical composition of particles is energy dispersive X-ray analysis (EDX), which gives an elemental analysis of the substance in the SEM viewing area. The EDX pattern of the spore picture confirms a carbon (thus organic) composition of the particles. EDX has been useful in recognizing the composition of other fossils and sediment particles. The minute details of a petrified redwood tree are visible in the SEM view in figure 3.

The lake deposits frequently show an alternation of volcanic ash and diatom layers (fig. 4). The famous insects, leaves, and other fossil remains commonly occur entombed in the fine ash. Apparently, their delicate remains were not disturbed as they were buried in the fine volcanic ash, which was washed into the lake basin from land or fell from ash clouds over the lake itself. Figure 4 shows layers of ash and diatoms. As our study continues, we wish to determine the period of time represented by an ash-diatom couplet (or pair). In some lake deposits, couplets represent 1 year of deposition. Determining the time represented by the couplets in the Florissant deposits would help determine the duration of the lake's existence.

Another aspect of our study is to learn about the chemical changes that take place in volcanic sediments during and after deposition. Geologists commonly know that volcanic ash weathers to a clay mineral called smectite. The shapes of the ash particles are indicators of the weathering processes. Our results have shown details (fig. 5) of the process of a volcanic

to continue gathering more evidence of features at the microscopic level because it promises to reveal further clues about lake history. Currently underway is a detailed study to determine the geological features present in sediments deposited near the ancient lake shore and along a traverse out into the center of the lake itself. Results should provide clues of the constancy of or amount of change in sedimentary lake processes and thus help in reconstructing ancient lake history. Results of this study including the SEM photos also are to be arranged in an interpretive display for the visitor center. Our contribution shows that there is another facet of the Florissant fossil beds, which is revealed in the intriguing "world of the micron."

PS

LITERATURE CITED

McLeroy, C.A., and R.Y. Anderson. 1966. Lamination of the Oligocene Florissant Lake deposits, Colorado. Geological Society of America Bulletin **77**:605-618.

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grain (see the arrow) changing to clay (C in fig. 5). Our future investigations will attempt to determine morphological differences between airborne and washed-in grains in order to understand the geologic events responsible for filling in the lake.

FURTHER STUDIES

To date, our observations reveal an abundance of small-scale fossils and mineralogical evidence in the ancient lake deposits. Much of this evidence has not been previously obtained simply because no one used the scanning electron microscope to journey into the microscopic world. Also, the other remarkably preserved and larger fossils have absorbed the attention of most investigators. We hope

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