

The Dynamics of Fossil Lake

By H. Paul Buchheim and Rachel Benton

Fossil Butte National Monument is contained within the ancient boundaries of Fossil Lake, one of three Eocene freshwater lakes located in present day southwestern Wyoming, Utah, and Colorado. The monument encompasses only a small fraction of the ancient lake, which extended 40 miles at its longest point. During 2 million years of deposition, great numbers of fossil fish, reptiles, birds, and plants representing a subtropical environment were preserved in the lake sediments. The present day Fossil Butte and Angelo members of the Green River Formation (Oriol and Tracey 1970) are the depositional product.

Because of the excellent preservation of both the

fossils and the lake deposits, Fossil Lake has been studied extensively. The fossil fish fauna were described in detail toward the end of the 19th Century (Cope 1884). Other workers have followed with further systematic descriptions, including the most recent monographs of Grande (1982, 1984, 1985, and 1991). McGrew and Casilliano (1975) and McGrew (1975) dealt with some taphonomic aspects of fossil fishes in Fossil Basin.

One of the first attempts to develop a depositional model for Fossil Lake was completed by Bradley (1948), providing an explanation for the burial and preservation mechanism of fishes at Fossil Lake. Further depositional models of these units were put forth by Buchheim and Eugester (1986)

and Buchheim (1990).

Present day research at Fossil Butte involves studies of lake depth, turbidity, salinity, alkalinity, temperature, and faunal elements. These features in turn provide clues to paleoclimatic interpretation. Many of these conclusions are based on changes in thickness and lithology of individual rock units. Also, the interaction of deltas and fluvial inlets with the main lake body provide information on lake evolution and dynamics.

Researchers in the past have interpreted thin laminae found in the Green River shales as "varves" or records of seasonal deposition. Recent studies within Fossil Basin have included laminae

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counts between two time-synchronous units (tuff deposition occurs during one "instant" in geologic time) (Buchheim and Biaggi 1988). Because the same amount of time is represented, the laminae counts between the two tuff beds should be consistent throughout the lake deposit. However, a 32 percent increase in laminae number and thickness occurs toward the basin margin. Sedimentation rates appear to be greater toward the shoreline (Fig. 1) due to an influx of calcium rich waters delivered from intermittent storm runoff, river inflow, and possibly calcium rich springs. As the calcium rich waters come in contact with the alkaline lake waters, calcium carbonate precipitates. A model based on seasonal deposition, as stated by the varve theory, does not appear to pertain to the Fossil Lake sediments.

Fossil Lake has classically been considered a freshwater lake. However, recent studies have indicated that periods of increased salinity occurred at various times in the lake's depositional history. Saline content is based on variations in calcite-dolomite ratio, tuff bed mineralogies, oxygen isotopes, and paleontology.

The lower two-thirds of the lake sequence is dominated by finely laminated micrites that are interbedded by a number of massive dolomites. The data indicate that Fossil Lake fluctuated from fresh to hypersaline, probably due to sudden fresh

water expansions followed by more gradual regressions. The upper third of the sequence is composed of massive dolomites containing salt casts, indicating that Fossil Lake was dominated by hypersalinity near the end of its existence.

Many questions pertaining to the dynamics of Fossil Lake remain. Research plans for this summer require further collection of rock samples, to be analyzed in the lab by x-ray diffraction, total organic carbon, thin sectioning, and isotope analysis. The goal is to produce 7 time slice maps, revealing lake changes through time and space. These maps will test the hypothesis that Fossil Lake was dynamic and underwent dramatic changes in chemistry, size, and shape through time. The goal is to determine the interaction between this ancient environment and its inhabitants.

Much of the knowledge gained in the last 15 years will be used to address a resource management project proposed for this summer. An extensive inventory on the fossil bearing units of the Green River Formation both within and outside the monument needs to be done. Baseline information such as this is crucial for addressing future land management issue between NPS and the Bureau of Land Management.

Dr. Buchheim is with the Dept. of Geological Sciences, Loma Linda Univ.; Benton is Park Paleontologist at Fossil Butte NM, Kemmerer, WY 83101.

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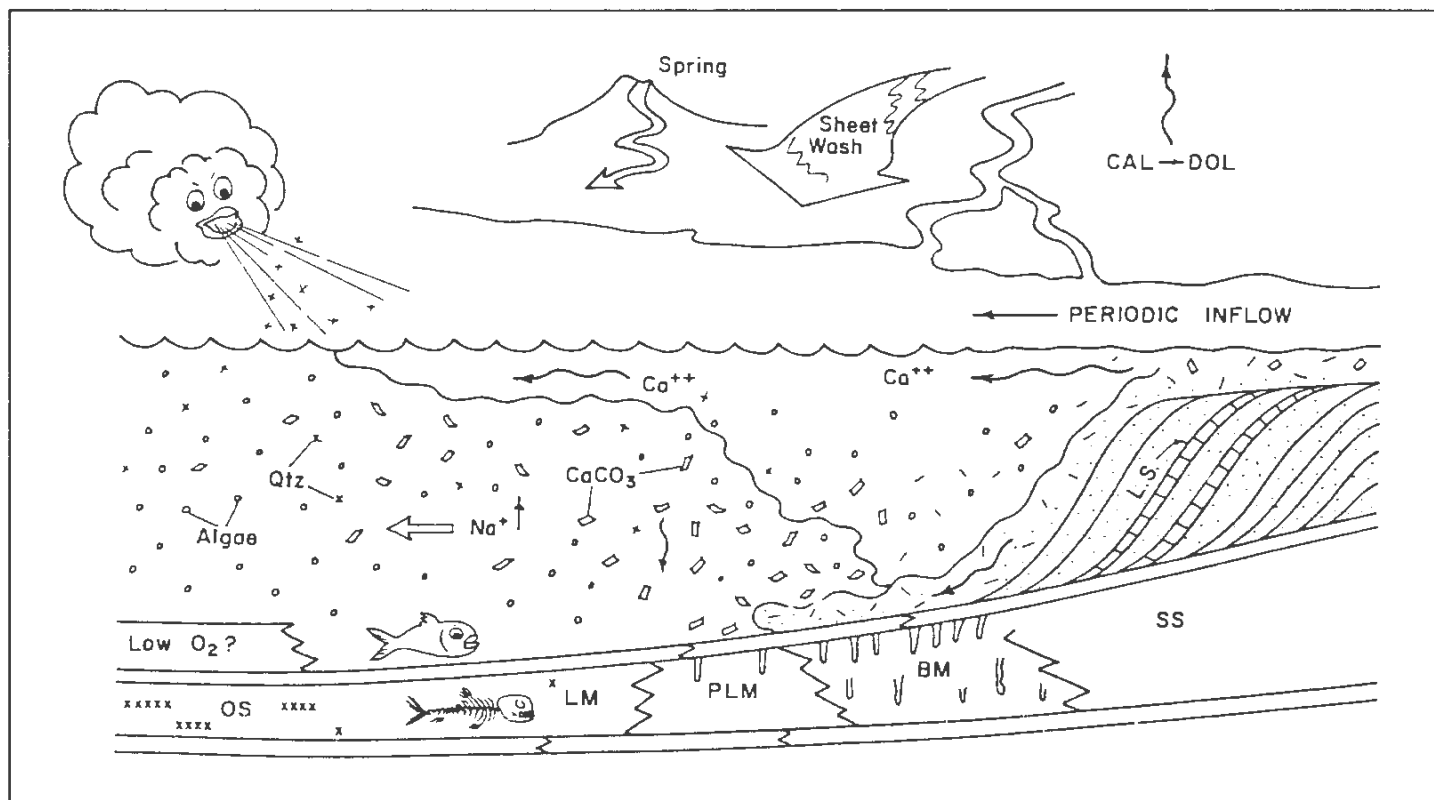


Figure 1. Depicted here are several lateral facies patterns found at Fossil Lake. Increased sediment deposition and a greater number of laminae characterize the lake margins, due to seasonal inflow and the precipitation of calcium carbonate. Highly reducing and organic rich sediments as well as an increase in salinity toward the lake's center enhanced the preservation of laminated sediments and fishes and discouraged bioturbators.

Abbreviations: Na+ = salinity; qtz = quartz; Ca++ = dissolved calcium; BM = bioturbated micrite; SS = siliciclastics; LM = laminated micrite; PLM = poorly laminated micrite.