MICROFOSSILS OF THE GREGORY SHALE MEMBER OF THE PIERRE FORMATION

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ABSTRACT

Preliminary investigation of the microfauna of the Gregory shale has disclosed the presence of species representing 10 different families of Foraminifera and 1 family of Ostracoda. In addition, some radiolarians are present in the upper Gregory.

Most of the foraminiferal tests are calcareous, but a few arenaceous forms are present. The fossil fauna represents benthonic and pelagic forms.

Ecologically, the genera suggest relatively shallow, warm seas of normal marine to brackish salinity, perhaps slightly on the alkaline side as indicated by pH evidence.

The Gregory shale shows possible correlation with the Taylor marl of Texas (Campanian) on the basis of foraminiferal evidence.

INTRODUCTION

Stratigraphically, the Gregory shale member is found in the lower portion of the Pierre formation, where it appears to conformably overlie the basal Sharon Springs member. The Gregory shale is overlain by the Sully member.

The Gregory member is exposed in outcrops along the Missouri River Valley from the vicinity of Yankton, South Dakota, to approximately 15 miles east of Pierre, South Dakota, where it disappears under the level of the Missouri River. The Gregory extends westward in the subsurface and outcrops with the lower Pierre in the Black Hills region. The Gregory extends southward under Nebraska and on into Kansas.

The type section from which the Gregory member was originally described outcrops near the old Rosebud bridge, in Gregory county, South Dakota.

The examined microfauna were recovered from channel samples taken at 5 foot intervals in outcrops adjacent to the Missouri River throughout the total outcrop area.

The Gregory shale member of the Pierre formation consists mainly of medium to dark-gray shales, interfingered calcareous and chalky shales, and the upper limits being dominantly light-buff to

light-gray marls throughout southeastern and central South Dakota. Other significant characters are bentonite beds; laterally varying, inter-stratified layers of limy concentrations, and abundant brown, iron-brown fossiliferous concretions scattered throughout the Gregory.

The lithology of the Gregory, as of the Pierre in general, is representative of the depositing of fine, dark-gray to black muds under relatively stable, quiet marine conditions. Volcanism was prominent during the time of Gregory deposition, and the abundant bentonite beds undoubtedly contributed much to the character of the sediments during the lithification and diagenesis of the sediments and volcanic ash.

The Gregory member varies in thickness from 60 to 145 feet in the field areas from which samples were collected for microfaunal inspection. The variance in thickness throughout the area of exposure, and the fact that the Gregory thickens to the west, may suggest possible times of non-deposition due to minor fluctuations in the coverage of the Late Cretaceous seas. This region was quite far from the major sediment source area which was to the west, and undoubtedly received very little sediment from the lowland to the east; other than some fine detritus.

Decrease in the number of bentonite beds from the west to the east points to possible times of erosion between deposition of the fine detrital and chemical sediment.

Inoceramus, a pelecypod genera, is represented by 4 or 5 species. Cephalopods are represented by the genus *Baculites*. Reeside (1957) suggests the presence of cephalopods indicate favorable life conditions, and are generally found in fine silt and calcareous deposits. The overall environment was probably that of the neritic zone.

From a picked set of samples representing nearly a complete thickness of Gregory section west of Chamberlain, South Dakota, the following was noted: *Gyroidina* persists throughout; *Ammodiscus* abundant in the upper Gregory, none in the lower Gregory; *Globigerinella* decreasing upward in the lower half of the Gregory; *Nodosaria* and *Dentalina* more numerous in the lower Gregory. Other species include *Robulus, Clavulinoides, Loxostomum, Globoratalites, Gumbelina, Dorothia,* and *Globotruncana.*

The Ostracoda are represented by the subfamilies Cytheridininae and Cytherinae. *Brachycythere* is thought to be one of the species, although this has not been positively identified.

Foraminifera indicate marine conditions, and in general shallow, warm water environments. It must be realized that there are many exceptions to this rule.

Benthonic foraminifera make excellent time markers as they are relativley stationary animals, moving about very little over the sea bottom. Upon death, they are quickly buried by the finest of sediments. The families Rotaliidae, Lagenidae, Verneuilininae, and Nonionidae, all benthonic, have representative forms in the Gregory shale.

Planktonic foraminifera indicate off-shore water masses, and in most modern environments are found in the upper 50 meters of the surface, where they are directly affected by temperature and light, irregardless of what depth they might exist.

Conditions for life were no doubt quite favorable, though the fineness of the sediment could imply rather turbid water was present. The wide variety of species present and the presence of fossil life conditions throughout the Pierre indicate satisfactory life development.

There is no evidence of abundant plant life during Gregory deposition, because the fine mud bottoms were too soft to support plant growth, or possibly the water was too turbid for the proper light and nutrients. A lack of plant life due to the fine nature of the sediments may indicate low oxygen content due to poor circulation in quiet seas. However, the writer does not believe the oxygen content to have been near to approaching anaerobic conditions, due to the abundance of life forms.

Temperature evidence as based upon modern genera of Cretaceous foraminifera suggests a range of 3°C - 16°C (37°F - 60°F) in a zone of 15-90 meters in depth. It is in this range that the abundance of modern genera having Gregory forebearers occur.

The abundance of calcareous nature sediments in the lower Pierre suggests that seas were relatively warm and slightly on the alkaline side. A pH of 7.8 will put calcium carbonate into solution, which in turn points to less acid conditions. Temperature also has an effect on the CO_2 dissolved in the water, which is also a controlling lime content factor.

Calcium carbonate is rather independent of Eh, that is Oxidation-Reduction potential, and for this reason a reducing or oxidizing environment would not matter too significantly (Krumbein, 1952).

Manganese oxides, in reference to the abundance of iron-manganese in the overlying Sully member, is dependent on the Eh. Negative Eh will allow only the slight formation of manganese oxides, whereas a positive Eh is highly desirable. Toward the end of Gregory deposition perhaps the Eh was changing to a positive value, as indicated by the abundance of iron-manganese in the Sully mem-

ber. The high calcareous nature, however, carries through. This fact is raised only to prove a point.

Schuchert (1943) has correlated the Gregory member with the Taylor marl of Texas. This corresponds in time to the Campanian and Late Santonian.

Examination of work on the foraminifera of the Saratoga chalk (Cushman, 1931), Annona chalk (Cushman, 1932), and the Grayson formation (Tappan, 1940) of Texas, all of approximately the same age, show a striking resemblance certainly in the genera, and in many of the species.

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