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Paragenesis of the Morgan Creek Limestone, Late Cambrian, central Texas: Constraints on the formation of glauconite

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Abstract

Deposition of the Morgan Creek Limestone, a member of the Cambrian Wilberns Formation, began a few meters above a disconformable surface and displays abundant indicators of accumulation in shallow marine to tidal flat environments. These indicators include: intercalation of a lithologic variety of thin beds (e.g. biosparites, biomicrites, oosparites, intrasparites), which display rapid vertical and lateral lithologic changes, numerous stromatolitic horizons, channels filled with graded oosparites and intrasparites that cut through micrite accumulations, and finely laminated (non-burrowed) siltstones. Glauconite is a ubiquitous minor constituent throughout in the form of pellets, replaced skeletal material and mica books, and, most informatively, as an authigenic precipitate in the form of fibroradiating rims on carbonate allochems and siliciclastic grains.

Fibroradiating glauconite rims were disrupted and pushed away from the pelmatozoan nuclei on which they precipitated. Combined sedimentological and paragenetic constraints indicate that the glauconite was the earliest diagenetic event to affect these sediments and occurred essentially at the sediment–water interface within these relatively high-energy, shallow marine deposits. Precipitation of glauconite was closely followed by precipitation of carbonate cement as well as dissolution of aragonitic constituents. Later diagenetic processes included selective dolomitization and silicification.

In modern seas glauconite is reported to form at and below mid-shelf water depths. Thus, the constraints pertaining to the origin of modern glauconite are not valid for Late Cambrian deposits and probably are also not applicable for Late Cretaceous through Early Paleogene glauconites.
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Keywords: Glauconite; Diagenesis; Cambrian; Texas

1. Introduction

Modern glauconite is commonly reported as forming slowly, under low-energy conditions, in mid-shelf to deeper-water environments (Dias and Nittrouer, 1984; Bornhold and Giresse, 1985; O'Brien et al., 1990; Rao et al., 1993; Jach and Starzec, 2003). For in-depth discussions concerning the processes of glauconitization the reader is referred to Galliher (1935), Takahashi (1939), Cloud (1955), Burst (1958a, b), Odin and Matter (1981), Clauer et al. (1992), Kelly and Webb (1999), and Kelly et al. (2001). Using the "present is the key to

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the past'', studies pertaining to the rock record commonly cite the presence of glauconite *a priori* as an indicator of deposition in water 50 m or greater in depth. However, sedimentological and paragenetic constraints provide evidence that some ancient glauconitic deposits formed in the shallow marine realm, under high-energy conditions, and probably fairly rapidly (Huggett and Gale, 1997; Chafetz and Reid, 2000). This investigation provides additional evidence that depositional conditions during the Late Cambrian differed from those of modern glauconite accumulations. Sedimentologic and petrographic data related to the deposition and diagenesis of the Morgan Creek Limestone are reported to provide an understanding of the paragenesis of these Cambrian strata and, of particular interest, insights into the timing and conditions of formation of Cambrian glauconite.

2. Methods

Field work, petrographic, X-ray diffraction, scanning electron microscopic, and microprobe analyses have been conducted since the mid-1960s to the present on the rock units comprising the Wilberns Formation; consequently, a wide variety of methods of analyses have been used. Analyses of over 1000 slabbed and etched samples complement point counts on approximately 200 thin sections. Many of the thin sections and rock slabs were stained with a mixture of Alizarin red S and potassium ferricyanide in an acid solution (Evamy, 1963); this was used to distinguish calcite from dolomite as well as indicate the relative amount of ferrous iron within the calcite and dolomite.

3. Depositional environments

The Morgan Creek Limestone is a part of the Upper Cambrian to Lower Ordovician Wilberns Formation (Fig. 1). The Wilberns is disconformably underlain by the Riley Formation and conformably overlain by the Ellenberger Dolomite. The Wilberns strata crop out in central Texas, USA, and, in ascending order, consist of the Welge Sandstone, which is gradationally overlain by the Morgan Creek Limestone, which interfingers with and is gradationally overlain by the Point Peak Siltstone, and the sequence is capped by the dolomitic San Saba Member (Barnes and Bell, 1977).

The unconformity between the Riley and Wilberns formations is craton-wide, extending from the

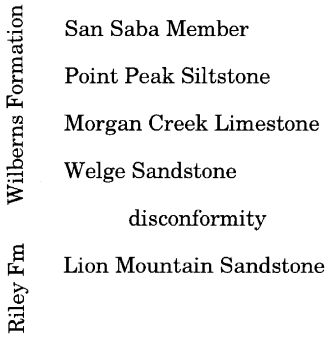

Fig. 1. Stratigraphic column showing relative position of the Morgan Creek Limestone.

Upper Mississippi Valley into central Texas. However, it does not exist between the Riley and Wilberns in the subsurface strata to the south of the outcrop area (Barnes et al., 1959). Thus, the Late Cambrian seas regressed from the Upper Mississippi Valley into central Texas and no farther prior to transgressing and depositing the Wilberns and younger units.

The lowermost part of the Wilberns Formation, the Welge Sandstone, was deposited superjacent to the exposure surface. This medium-grained glauconitic sandstone ranges from 5 to 7 m thick (Dekker, 1966). Cross-stratification structures are abundant and display a bimodal distribution, primarily the result of sediment transport by tidal currents in a shallow marine realm. Pelmatozoan fragments are the most abundant fossil debris, with phosphatic brachiopods and trilobites comprising only trace amounts of the rock. Calcite is the predominant cement; nevertheless, the reflection of sunlight off of the authigenic quartz overgrowths makes them readily apparent in the field as well as in thin section. Additionally, authigenic potassium feldspar overgrowths are present on feldspar grains and authigenic glauconite cement forms coatings on quartz grains (Chafetz and Reid, 2000). The unconformity at its base, marine skeletal debris, presence of authigenic potassium feldspar, and authigenic glauconite, in addition to the cross-stratification structures and lack of fine-grained material indicate that the Welge Sandstone accumulated in a turbulent shallow marine environment during the initial phase of a marine transgression. The contact with the overlying Morgan Creek Limestone is readily evident though gradational as indicated by the marked decrease in the abundance of medium sand-sized quartz grains through an interval of less than a meter.

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