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RESEARCH ARTICLE | OCTOBER 01, 1978

Volume 89, Number 10
October, 1978

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GSA Bulletin (1978) 89 (10): 1559-1573.

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https://doi.org/10.1130/0016-7606(1978)89<1559:LMAELO>2.0.CO;2

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Abstract

Six limestone classes occur in the Ordovician strata from Lexington, Kentucky, to Nashville, Tennessee. Sediments that make up classes 1 through 4 were deposited in “open” epicontinental marine environments, whereas classes 5 and 6 reflect more “restricted” environments. These classes were used to calculate relative mechanical energy and depth indices for a defined time-stratigraphic interval. The base of this interval is a bentonite bed that occurs near the base of the Brannon Member of the Lexington Limestone, and the top is defined by a major change in the relative abundance of platform conodonts. Relative mechanical energy and depth contours intersect the present axis of the Cincinnati arch at a high angle, which suggests that a continuous arch was not present. Shoal environments existed in the Lexington area and northeast of the present Nashville dome. These shoals correspond to the positions of the Lexington and Nashville domes or precursors to these domes which were present during the defined time interval. Paleobathymetric contours parallel east- and south-trending normal faults that are present in and south of the Lexington, Kentucky, area. This suggests that these faults were active during late Middle Ordovician time and were partly responsible for creating the bathymetric relief necessary for higher-energy carbonate sediments to accumulate. Deeper-water environments between the two shoal areas reflect the presence of the Rome trough. The general bathymetric trend for these strata is one of submergence.

GeoRef Subject

folds limestone Kentucky Middle Ordovician Ordovician microfossils paleogeography Tennessee sedimentary rocks Paleozoic Upper Ordovician carbonate rocks Cincinnati Arch Eastern U.S. stratigraphy tectonics structural geology sedimentation United States

First Page Preview

Late Middle and early Late Ordovician history of the Cincinnati arch province, central Kentucky to central Tennessee

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ABSTRACT

Six limestone classes occur in the Ordovician strata from Lexington, Kentucky, to Nashville, Tennessee. Sediments that make up classes 1 through 4 were deposited in "open" epicontinental marine environments, whereas classes 5 and 6 reflect more "restricted" environments. These classes were used to calculate relative mechanical energy and depth indices for a defined time-stratigraphic interval. The base of this interval is a bentonite bed that occurs near the base of the Brannon Member of the Lexington Limestone, and the top is defined by a major change in the relative abundance of platform conodonts. Relative mechanical energy and depth contours intersect the present axis of the Cincinnati arch at a high angle, which suggests that a continuous arch was not present. Shoal environments existed in the Lexington area and northeast of the present Nashville dome. These shoals correspond to the positions of the Lexington and Nashville domes or precursors to these domes which were present during the defined time interval. Paleobathymetric contours parallel east- and south-trending normal faults that are present in and south of the Lexington, Kentucky, area. This suggests that these faults were active during late Middle Ordovician time and were partly responsible for creating the bathymetric relief necessary for higher-energy carbonate sediments to accumulate. Deeper-water environments between the two shoal areas reflect the presence of the Rome trough. The general bathymetric trend for these strata is one of submergence.

INTRODUCTION

Geologic Setting

The inner Blue Grass region of Kentucky through the north-central area of Tennessee (Fig. 1) is partly underlain by biogenic limestones and calcareous shales of late Middle and early Late Ordovician age. These strata are assigned to the Lexington Limestone and Clays Ferry Formation in Kentucky and the Hermitage, Bigby-Cannon, and Catheys Formations in Tennessee (Fig. 2).

These limestones and calcareous shales are brought to the surface in limited exposures in the areas around Lexington, Kentucky, and Nashville, Tennessee, by two geologic structures — the Lexington (Jessamine) dome in the north and the Nashville dome in the south. The axis of the Cincinnati arch passes through these two domes (Fig. 1).

The Lexington dome is a broad, irregular but gentle structure with strata dipping generally from 3.79 to 5.68 m/km (20 to 30 ft/mi) westward and somewhat less northward (Cressman, 1973, p. 8). Two major normal fault systems, the West Hickman–Bryan Station and the Kentucky River fault systems, transect the Lexington dome (Fig. 1). The Kentucky River fault system is a zone of normal faults and grabens trending from northeast to east-northeast with a general sense of displacement down to the southeast. The West Hickman fault system nearly joins the northeast-trending part of the Kentucky River fault system in southern Jessamine County and extends northeastward into Bourbon County (Black and Haney, 1975, p. 1). The Kentucky River fault system and the proximal Irvine–Paint Creek fault system most likely represent an ancient structural element or elements of transcontinental proportions involving Precambrian basement (McGuire and Howell, 1963; Bayley and Muehlberger, 1968; Webb, 1969; Heyl, 1972).

Wilson (1935) described the Nashville dome as an anticlinal structure that forms the southern end of the Cincinnati arch and occupies all of central Tennessee. The highest point on the dome along the axis of the Cincinnati arch occurs in south-central Rutherford County. From this point the axis of the dome dips about 1.52 m/km (8 ft/mi) to both the southwest and northeast. The average dip on the northwest and southeast flanks of the dome is about 3.03 m/km (16 ft/mi). Faulting on the Nashville dome is not common, but small normal faults occur (Wilson, 1935). These faults are usually only a few kilometres long and have vertical displacements of as much as 91.4 m (300 ft) but more commonly closer to 15.2 m (50 ft).

The Lexington and Nashville domes are separated by a structural saddle (Cumberland saddle), which trends almost normal to the axis of the Cincinnati arch (Fig. 1). In this saddle, the Chattanooga Shale is topographically as much as 213.4 m (700 ft) lower than on the crest of the Nashville dome (Wilson, 1935).

Previous Stratigraphic Work

The Cincinnati "geanticline" was described by John Locke in 1838. Locke's description of this structure as well as many other important early studies in the Cincinnati arch province were summarized by Schuchert (1943, p. 539–545). In Kentucky, recent work by personnel of the U.S. Geological Survey, the Kentucky Geological Survey, and the University of Kentucky has resulted in constructing a workable lithologic framework for the major units within the Lexington Limestone and Clays Ferry Formation. Recent publications resulting from this work include Black and others (1965), Black and MacQuown (1965), Cressman and Karklins (1970), MacQuown (1967), Weir and Greene (1965), Hrabar and others (1971), Mackey (1972), Black and Cuppels (1973), Hopkins (1975), Etter (1975), Cressman and Noger (1976), and a series of U.S. Geological Sur-

Geological Society of America Bulletin, v. 89, p. 1559–1573, 10 figs., 1 table, October 1978, Doc. no. 81011.

Index Terms/Descriptors

arches biostratigraphy carbonate rocks Cincinnati Arch classification Conodonta controls correlation domes Eastern U.S. energy environment folds Kentucky limestone lithofacies marine environment microfossils Middle Ordovician Ordovician paleobathymetry paleogeography Paleozoic sedimentary rocks sedimentation statistical analysis stratigraphy structural controls structural geology structure subsidence tectonics Tennessee United States Upper Ordovician

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