OXYGEN-CARBON ISOTOPE STRATIGRAPHY OF UPPER CARBONIFEROUS TO LOWER PERMIAN MARINE DEPOSITS IN MIDCONTINENT U.S.A. (KANSAS AND NE OKLAHOMA): IMPLICATIONS FOR SEA WATER CHEMISTRY AND DEPOSITIONAL CYCLICITY

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ABSTRACT: Late Pennsylvanian (upper Gzhelian = Virgilian) to early Permian (lower Artinskian = upper Wolfcampian) sea water chemistry and depositional cyclicity are evaluated based on oxygen and carbon isotopic compositions of unaltered shells of the brachiopod *Composita* collected from shallow-water deposits in the Council Grove and Chase Groups in Kansas and Oklahoma. Mean $MgCO_3$ content in these samples is 0.2 ±0.2 mole%, and mean $\delta^{18}O_{PDB}$ and $\delta^{13}C_{PDB}$ values are -2.1 ±0.6‰ and 4.0 ±0.8‰, respectively. There is no significant difference in mean percentage $MgCO_3$ or isotopic compositions between primary prismatic and secondary fibrous shell layers. $\delta^{18}O$ trends do not appear to coincide with inferred sea water temperature changes attending deposition of stratigraphic sequences as has been postulated for older midcontinent Pennsylvanian cyclic deposits. Rather, the data seemingly reflect variations in sea water $\delta^{18}O$ values coincident with ice-volume fluctuations during the time period examined. This contention is in accordance with inferred glacio-eustatic forcing of depositional cyclicity in the section. Estimated amplitudes of sea-level fluctuations increase from the upper Gzhelian into the lower Artinskian from 30-100 m to 110-150 m, which concurs with maximum Gondwanan glaciation during the early Permian. Although there is not a significant long-term trend in mean $\delta^{13}C$ values, there is an upward trend to less negative $\delta^{18}O$ values that is interpreted as a signal of long-term increase in midcontinent aridity and salinity.

INTRODUCTION

Studies of the stable oxygen and carbon isotopic compositions of biotic and abiotic components in limestones have furthered our understanding of changes in sea water isotopic composition and temperature, global carbon budgets, history of glaciation, and deposition of cyclic sequences (e.g., Lowenstam 1961; Galimov et al. 1975; Veizer and Hoefs 1976; Veizer et al. 1980; Popp et al. 1986a; Beauchamp et al. 1987; Bruckschen et al. 1999; Mii et al. 1999). Such geochemical data also provide critical baselines against which isotopic compositions of cements and dolomite in ancient carbonate rocks are compared and interpreted (e.g., Given and Lohmann 1985; Lohmann and Walker 1989; Carpenter et al. 1991). The late Paleozoic is a focus of such studies because it was a critical period in Earth history that witnessed dramatic environmental changes coincident with Gondwanan glaciations and the transition from ice-house to greenhouse climatic modes (Veevers 1994; Veevers et al. 1994). Marine oxygen and carbon isotope records have been developed for the late Paleozoic from several areas in the world (e.g., Compston 1960; Veizer and Hoefs 1976; Popp et al. 1986a; Bruckschen et al. 1999), including a relatively detailed record for the Carboniferous of North America (Mii et al. 1999; Grossman et al. 2001a, b).

Available isotope data from upper Paleozoic rocks in North America are based largely on either whole brachiopod shells or rock matrix (Brand 1982, 1987; Morrison et al. 1985; Wiggins 1986; Magaritz and Holser 1990), which generally are considered equivocal because of likely diagenetic effects. Unaltered brachiopod shells and marine cements in limestones are believed to provide more reliable isotopic data (Given and Lohmann 1985; Popp et al. 1986b; Lohmann and Walker 1989; Grossman 1994; Grossman et al. 1996). Limited marine cement data are available for the upper Paleozoic in North America (e.g., Davies and Krouse 1975; Davies 1997; Given and Lohmann 1985, 1986; Beauchamp et al. 1987; Graber 1989; Mruk 1989; Dickson et al. 1991; Mazzullo 1999b), but the bulk of available data from rocks of this age are from well preserved brachiopod shells (Popp et al. 1986; Veizer et al. 1986; Adlis et al. 1988; Grossman 1994; Grossman et al. 1991, 1993, 2001a and b; Mii et al. 1999). Whereas Carboniferous rocks in North America have been fairly well studied, there is a critical gap in brachiopod data from younger Paleozoic rocks, particularly from upper Gzhelian to Artinskian strata. This gap limits attempts at paleoclimatic modeling, comparative sedimentologic, diagenetic and biotic studies, and other reconstructions.

This paper presents oxygen and carbon isotope data from unaltered brachiopod shells in upper Gzhelian to lower Artinskian (upper Virgilian to upper Wolfcampian), cyclic shallow-marine strata of the Council Grove and Chase Groups in central to southern Kansas and northeastern Oklahoma. These data extend the brachiopod isotope chemostratigraphy of Adlis et al. (1988), Grossman et al. (1991, 1993), and Mii et al. (1999) into the lower Permian, and allow direct comparison of isotope data from a similar sample base. Based on these data, late Paleozoic ocean chemistry and temperature, history of glaciation, and depositional cyclicity of these rocks are evaluated and discussed.

STUDY AREA AND STRATIGRAPHY

The Council Grove and Chase Groups are exposed

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