

Hirnantian (Latest Ordovician) Strata in the Heart of the Continent? Intriguing Results from Williston Basin, Manitoba

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A distinctive, positive, latest Ordovician, Hirnantian isotopic carbon excursion (HICE) has previously been dated in areas where biostratigraphic control is relatively good. In North America, such areas occur near the continental margin. By extension, the presence of HICE has been used to confirm the Hirnantian age of strata where biostratigraphic control is less certain or is equivocal. Thus, a Hirnantian age has been supported for strata in the eastern interior of North America (Missouri, Illinois). Furthermore, recognition of HICE itself has led to suggestions that the Hirnantian is also represented in southern Ontario. It seems that latest Ordovician strata are more widely distributed on the North American craton than was previously thought.

The present study is the first to integrate isotopic data with litho- and biostratigraphy across the Ordovician-Silurian boundary as previously recognized in the centre of North America. The O-S boundary in the Williston Basin had been placed in the upper part of the Stonewall Formation, at a major conodont extinction event. The Late Ordovician conodont fauna is abruptly followed by one of Early Silurian aspect including *Ozarkodina hassi*. In Manitoba, this boundary had been located in an interval associated with the *t*-marker bed. It was recognized that the conodonts of Silurian aspect range into the latest Ordovician in some areas near the continental margin. In the Williston Basin, however, their appearance was considered to be Silurian, because it was thought that latest Ordovician and earliest Silurian strata were probably absent in the cratonic interior due to a major regression caused by glaciation in Gondwana.

In addition to a previously known roadcut, the present study includes a new roadcut and drillcore about 100 km away. Isotopic analyses from the drillcore and new roadcut reveal a positive $\delta^{13}\text{C}_{\text{carb}}$ excursion beginning in the lower part of the *t*-marker bed, reaching a peak in the mid to upper part of the bed, and decreasing in Stonewall strata above the bed. At the new roadcut, the *Ozarkodina* fauna appears in the middle of the *t*-marker. At the previously known roadcut, a positive $\delta^{13}\text{C}_{\text{carb}}$ excursion begins at the bottom of the *t*-marker, reaches a peak above the bed, and decreases in the uppermost Stonewall. At the peak of the excursion, the Ordovician conodont fauna is succeeded by the *Ozarkodina* fauna. The base of the argillaceous *t*-marker bed seems to represent a significant discontinuity. A negative $\delta^{13}\text{C}_{\text{carb}}$ excursion beneath that surface at both roadcuts is consistent with subaerial exposure. Above that surface, siliciclastic material in the *t*-marker decreases upward. The most prominent lithostratigraphic discontinuity above the base of the *t*-marker is at the top of the Stonewall Formation.

At both localities in Manitoba, the *Ozarkodina* conodont fauna appears at or near the peak of the positive $\delta^{13}\text{C}$ excursion in the upper Stonewall Formation. On Anticosti Island, Quebec, the *Ozarkodina hassi* zone begins in the middle of the major HICE excursion. In northeastern Illinois, where the magnitude of the HICE peak is relatively low (values about +2.5‰), *O. hassi* appears in the upper part of the excursion where values are decreasing. In Manitoba, the coincidence of the positive excursion (maximum +2‰) with the appearance of the *Ozarkodina* fauna, suggests that this excursion may represent HICE. Strata recording at least part of Hirnantian time may therefore be preserved in the Williston Basin, and the Ordovician-Silurian boundary may be at a higher stratigraphic position than previously thought.