Nd isotope evidence for provenance of the terrigenous fraction of deglacial sediments in the Orca Basin, Gulf of Mexico

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Documentation of the routing of fresh water runoff during disintegration of the Laurentide Ice Sheet is important to understanding the impact of glacial fresh water contributions to thermohaline circulation in the North Atlantic. During the Last Glacial Maximum, the Gulf of St. Lawrence drainage was blocked, and glacial lakes Agassiz and Superior were damned and filled with meltwater (Broecker *et al.*, 1989). Oxygen isotope data from foraminifera of the Orca Basin in the Gulf of Mexico have been used to suggest that catastrophic meltwater floods from these glacial lakes were channeled down the Mississippi River, starting about 18 ka and ending by 10.5 ka (Leventer *et al.*, 1982). After the ice sheet retreated far enough to the north, fresh water from the melting ice was sent directly into the North Atlantic via the St. Lawrence River drainage. It has also been suggested that this change in meltwater routing could have been the trigger for the Younger Dryas cooling (Rooth, 1982; Broecker *et al.*, 1989). The suggestion that it is possible to temporarily shut down deep water formation in the North Atlantic by adding a spike of fresh water through the St. Lawrence drainage, thereby reducing the transport of heat from northward-flowing, warm surface currents has been supported by global circulation models.

Work is in progress to evaluate radiogenic isotope evidence for variations in terrigenous sediment sources via the Mississippi River during late glacial and Holocene times. Previously, Hurley *et al.* (1961) documented that bulk, surface sediments from a variety of delta and pro-delta settings on the Mississippi River produce a relatively small range of apparent K-Ar ages of 214 to 357 Ma. In contrast, clay size fractions from normal gray sediments at various core depths within Mississippi Delta cores yield apparent ages of 145 to 206 Ma, and bulk sediment aliquots from these same samples yielded apparent ages of 280 to 390 Ma, similar to bulk sediment analyses of surface sediments. The interpretation of these results was that the coarsest potassium-rich fractions consist of minerals derived from crystalline rocks of the Appalachian Mountains with ages of *c.* 400 Ma. Hurley *et al.* (1961) also suggested that these coarser fractions additionally contained a larger proportion of illite, a stable, high-K mineral that is common in Palaeozoic shale deposits such as those tapped by the Ohio River. The finer fraction contains a larger proportion of smectite derived from younger, Cretaceous and Tertiary, sedimentary and volcanic sources to the west, via the Missouri River.

The truly impressive part of the Hurley *et al.* (1961) study was their data from a red-brown clay layer from down-core samples from two different cores. In contrast to the gray clay samples, bulk samples of this red-brown layer yielded apparent ages of 540 to 810 Ma! In order to have made such a tremendous impact on the provenance of sediment from such a mighty river as the Mississippi must have required an enormous and catastrophic flooding event. Hurley *et al.* (1961) reasonably interpreted the ancient age for the red-brown layer to be a product of sources from the southern Colorado Front Range via the Red River. An alternative hypothesis is that the flood might instead reflect one of the catastrophic floods known to have flowed into the Gulf of Mexico from glacial lakes pinned against the southern margin of the Laurentide Ice Sheet during its final phases.

An appropriate approach to testing reconstructions of drainage history is to analyse the radiogenic isotope composition of terrigenous sediments in the Orca Basin, a very anoxic basin located near the Mississippi Delta. The highly anoxic conditions tend to prevent biological disturbance of sediment layering and thus a detailed stratigraphy is possible. Several studies have been published on oxygen isotope evidence from Orca Basin cores for the occurrence of a large meltwater event in the Gulf of Mexico that ended shortly before the Younger Dryas (Broecker *et al.*, 1989). Due to the very reducing conditions in the Orca Basin, the red colouration noted by Hurley *et al.* (1961) on the Mississippi Delta would not likely be preserved in these sediments. New data collected for this study show that sediments from within the meltwater interval of core EN32 PC6

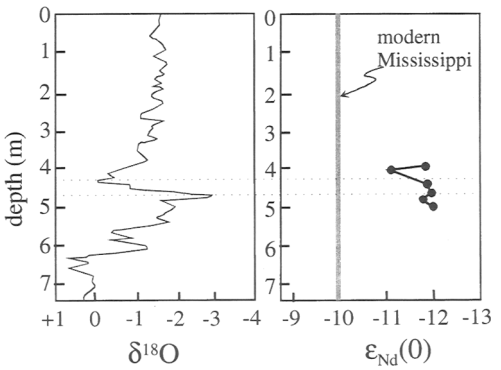

FIG. 1. Data from core EN32 PC6.

(26°56′N, 91°22′W, 2280 m) in the Orca Basin have ε_{Nd} of −12 to −12.5 (Fig. 1). Just above the meltwater interval one sample has an ε_{Nd} of −10.8, but a sample just above that has a lower value like those within the meltwater interval.

Modern lower Mississippi River sediments have ε_{Nd} of −10 whereas upper Mississippi River and St. Louis River sediments from Minnesota have ε_{Nd} of −20 (Goldstein and Jacobsen, 1982). Although not a unique interpretation, the lower ε_{Nd} measured in meltwater interval sediments can be explained by mixing between upper midcontinent sources (ε_{Nd} = −20, 25%) and lower Mississippi (ε_{Nd} = −10, 75%) sources. This is consistent with mixing of ca. 1500 Ma apparent K-Ar ages from the upper midcontinent with ca. 300 Ma ages from ambient Mississippi Delta sediments to produce 600 Ma such as those measured by Hurley *et al.* (1961). Preparations are underway to obtain additional isotope data (e.g. Ar-Ar, Pb, Sr) from these sediments as well as to analyse additional sediments from well outside the meltwater interval in order to test the working hypothesis presented here.

References

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