Multiple origins of negative $\delta^{13}C$ anomalies in the Neoproterozoic: The Tambien Group, Ethiopia - a Bitter Springs Stage to Sturtian (~800-735 Ma) sequence

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Many of the negative $\delta^{13}C$ anomalies identified in Neoproterozoic sequences are temporally associated with glacial deposits, perhaps the result of a "Snowball Earth". However, it is increasingly being recognised that some Neoproterozoic sequences contain negative carbon isotope anomalies that are *not* associated with glaciogenic rocks, demanding alternative explanations for their origin. The Tambien Group comprises 2-3 km of carbonate and clastic sediments, capped in one inlier by a glaciogenic diamictite. A composite section of the Tambien Group shows carbonate $\delta^{13}C$ of ~+6‰ at its base, decreasing upwards to twin lows of ~–4‰ separated by a brief excursion back to positive values, then rises again to a plateau of ~+6‰ before finally decreasing sharply to –2‰ beneath the diamictite at its top. No glaciogenic sediments are observed associated with the lower twinned negative anomalies. Geochemical indices suggest near pristine C- and Sr-isotope values are preserved. Together with existing radiometric age constraints these data indicate that the diamictite is Sturtian in age, and the lower negative C-isotope anomalies correlate with the non-glaciogenic Bitter Springs Stage recognised in Australia and Svalbard. The C-isotope fractionation between carbonate and organic matter decreases from +26 to +21‰ up through the second low in carbonate $\delta^{13}C$ before increasing to ~+29.5‰ in the rest of the sequence. These variations contrast with those from the Bitter Springs Stage in Australia and are attributed to differences in local environmental variables, probably temperature. Such differences are consistent with the recent proposal that the Bitter Springs Stage anomaly is the result of a pair of Inertial Interchange True Polar Wander events [1,2] which rotated Ethiopia into high latitudes during the anomaly, but kept Australia at relatively low latitudes.

References

[1] Halverson G.P., Maloof A., Schrag D., Dudas F. & Hurtgen M. (2006) *Chemical Geology, in press*. [2] Maloof A.C., Halverson G.P., Kirschvink J.L., Schrag D.P., Weiss B.P. & Hoffman, P.F. (2006) *GSA Bulletin in press.*