doi:10.1130/G32688C.1

Forum Comment

Condensation origin for Neoproterozoic cap carbonates during deglaciation

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Kennedy and Christie-Blick (2011) describe sequence stratigraphic relations among a thick succession of ca. 635 Ma glacial to postglacial sediments in the Amadeus Basin of central Australia, which pass basinward into ~3 m of laminated dolomicrite (Fig. 1A). They conclude that the cap carbonate was deposited during a protracted interval of geologic time, rather than during abrupt deglaciation. Carbon isotope profiles from successive sections along their Mount Capitor transect are also interpreted as being consistent with condensation of the cap carbonate unit. It is largely drawn from this last assertion, and in a context of dichotomy between sequence-stratigraphic and chemostratigraphic correlations, that this Comment is offered.

Two main data sets were presented in the paper: 1) a sequence stratigraphic framework of, and 2) carbon isotopic profiles ($\delta^{13}C$) through, the Gaylad Sandstone/cap carbonate interval between the Olympic Formation and Pertatataka Formation (Fig. 1).

Kennedy and Christie-Blick observe that all the $\delta^{13}C$ profiles show upsection decreases in values toward a similar $\delta^{13}C$ minimum of ~-5‰ at section tops (Fig. 1B). Assuming that similar $\delta^{13}C$ values are coeval, the isotopic profiles afford an opportunity to construct a chemostratigraphic framework from which durations of siliciclastic and carbonate accumulation in each component section may be independently determined.

Figure 1C presents a chemostratigraphic correlation (over the time interval of $\delta^{13}C$-sampled carbonate accumulation) with sections MS-8, 10, and 11; all compared with the thickest section, MS-7. If MS-7 represents 100% of the time interval, the rates of accumulation (of combined siliciclastic and carbonate sediments) of more condensed sections (MS-8, 10, and 11), decreases basinward from 53% to 29% to 25%, respectively (Fig. 1C). Moreover, condensation of the cap carbonate section (MS-11) must therefore largely reflect missing record at the base of the section rather than condensation. Over the time interval of carbonate accumulation, only ~35% of the time recorded in MS-7 is represented by the accumulation in MS-11. This means that mixed siliciclastic and carbonate accumulation was occurring at sections MS-7, 8, and 10, but coeval deposition at MS-11 was either not preserved or had not yet commenced. This chemostratigraphic correlation is inconsistent with the condensation mechanism as described by Kennedy and Christie-Blick, and at odds with the interpretation that the time-transgressive progradation of the overlying Pertatataka Formation controlled the duration of carbonate deposition.

Perhaps more importantly, assessment of the sequence-stratigraphic horizons within a context of chemostratigraphic constraints demonstrates that the two frameworks are fundamentally incompatible (Fig. 1D). Specifically, sequence boundaries (and intervening flooding surfaces) are not only strongly time transgressive, but the occurrence of the higher boundary (S3) in more basinward positions in fact predates that of the lower boundary (S2) in more proximal sections (Fig. 1D). This requires that somewhere, there is a fly in the ointment. If the sequence-stratigraphic framework is more correct, then $\delta^{13}C$ values in laterally successive sections are not the same age, and rather reflect spatially heterogeneous alteration of isotopic signatures after deposition. This scenario is difficult to accept given the consistency in $\delta^{13}C$ values at the tops of each section. Conversely, if the chemostratigraphic framework is more correct, then correlations of erosional surfaces designated as sequence boundaries may be in need of revision.

In summary, the description of sequence-stratigraphic relations in the Amadeus Basin and the $\delta^{13}C$ compositions of contained cap carbonate facies should afford an opportunity to integrate these two approaches and develop a broader understanding of this important interval of Earth history. However, as presented, the apparent incompatibilities preclude such an outcome.

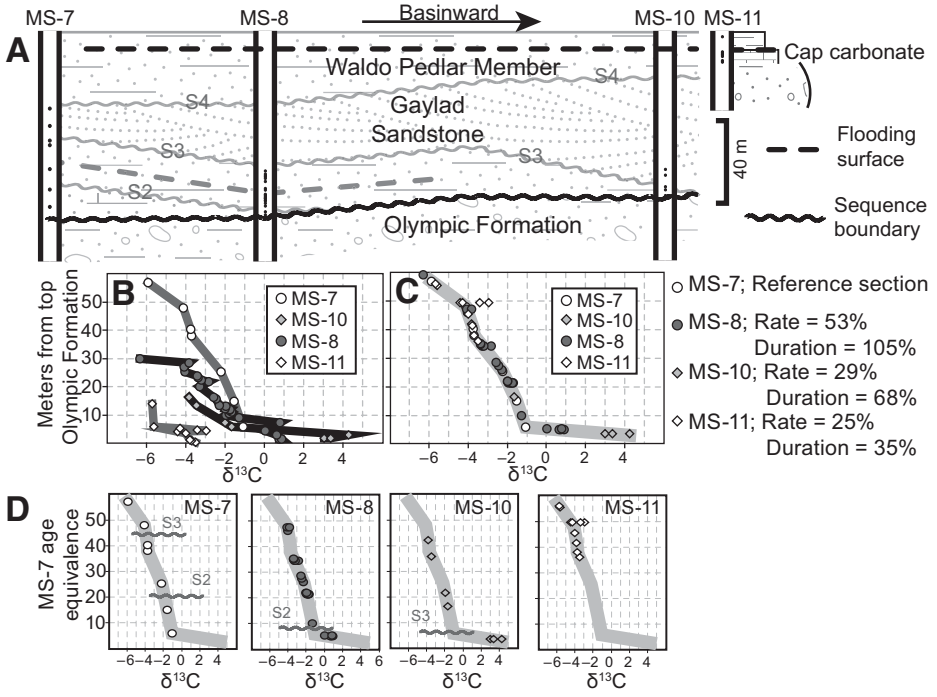

Figure 1. A: Sequence-stratigraphic relations among measured sections from the northeastern Amadeus Basin modified from Kennedy and Christie-Blick (2011); black dots are isotope samples from interfingered laminated cap carbonate facies. B: $\delta^{13}C$ values relative to distance from top of Olympic Formation. C: $\delta^{13}C$ values, accumulation rates, and net durations relative to reference section MS-7. D: temporal distributions of sequence boundaries if similar $\delta^{13}C$ values are coeval (Fig. 1C).

ACKNOWLEDGMENTS

Martin Kennedy graciously provided the isotopic values discussed here to BHW.

REFERENCES CITED

Kennedy, M.J., and Christie-Blick, N., 2011, Condensation origin for Neoproterozoic cap carbonates during deglaciation: Geology, v. 39, p. 319–322, doi:10.1130/G31348.1.