Paper Number: 2624

The enigma of the missing large regional erosional unconformity at the base of Marinoan Snowball Earth successions (northeastern Namibia)

Bechstädt, T.[1], Jäger, H.[1], Rittersbacher, A.[2], Spence, G.[3] and Joachimski, M.[4]

[1]GeoResources, Heidelberg, Germany. bechstaedt@georesources.de
[2]Statoil, Bergen, Norway
[3]Dep. Earth Sc., Univ. Bristol, U.K.
[4]Geozentrum Nordbayern, Univ. Erlangen, Germany

According to Snowball Earth hypothesis, the earth´s surface including the tropic oceans became entirely frozen during glacial episodes in the Cryogenian. Diamictite deposits are interpreted as product of grounding ice, associated with an extreme sea-level fall in the range of 1000 m [1]. On top of the diamictites the worldwide present cap carbonates occur. These are interpreted as chemical precipitates during a super greenhouse, causing a strong sea-level rise due to melting of all ice. In the Otavi Mountain Land (OML) of northern Namibia the classical diamictites of the Ghaub Fm are restricted to a slope, they are missing on the platform nearby. Cap carbonates are found in both areas. Absolutely no erosional unconformity was detected on the platform: different types of stromatolites, from metre-high columnar to wavy, show a distinct shallowing trend. Tubular features in the uppermost stromatolites are interpreted as due to degassing (melting of clathrates) [2]. These rocks are overlain by cap carbonates.

Carbon isotope values below the cap carbonates are regionally different in the OML. None of the sections exhibit the widely published strongly negative excursion, used for correlation and as argument for coeval Snowball Earth episodes. In a thick succession after the cap carbonates the $\delta^{13}C$ values are even more negative (often -5‰ VPDB) but relatively uniform in the different sections. This indicates local, facies-dependant water bodies underneath the Ghaub Fm., badly suited for worldwide correlations, and more uniform water masses during the post cap carbonate transgression.

The main sea level drop and build-up of ice must have occurred before the Ghaub time. The different types of stromatolites indicate shallowing within a photic area, a sea level fall comparable to the one in the Quaternary, but certainly not >1000 m. If we would assume the latter case, the platform should have been exposed for long times, and distinct lag deposits are to be expected during the subsequent transgression. Our data indicate a more limited amount of ice. The probably fluvioglacial material of the diamictites was shed from highlands in some distance. A strong warming pulse shortly before the cap carbonates caused the break up of ice; however, sediment-laden icebergs shed their load only locally. Glaciers reached the sea not everywhere: a strong counterargument against worldwide glacial cover including the oceans and worldwide extreme transgression. Another argument against Snowball Earth is the continuous record of life in OML. Fluctuations of sea level (indicated by changes of microbiota types) continue into the cap carbonates. The climate was still cold, near freezing (glendonite occurrences in the cap carbonates), not at all corresponding to a super-greenhouse. Distinct warming occurred after the

cap carbonates, causing a distinct transgression. Microbiotic life started to flourish, enhancing in local restricted areas the source rock potential for hydrocarbons.

In conclusion, a new model for the Cryogenian is needed, to explain low latitude glaciations, possibly restricted to highlands, coexisting with oceans widely ice-free in low latitudes, enabling continuous oceanic life.

References:

[1] Domack, EW and Hoffman, PF (2011) GSA Bull. 123:1448-1477
[2] Kennedy, MJ. et al. (2001) Geology 29:443-446