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Palaeoenvironmental signals from stromatolites of the Mesoproterozoic Stoer Group, N.W. Scotland

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The sedimentary environment and notably the climate conditions that pertained during deposition of the Mesoproterozoic (~1200 Ma) Torridonian Stoer Group have been subject to debate for some time. On one hand it has been proposed that, despite the low palaeolatitude, the Group is largely represented by fluvio-lacustrine sediments deposited under cold, possibly glacial conditions. On the other hand, evidence and arguments have been put forward in favour of either a marine, or arid to semi-arid terrestrial environment. Contributing to this debate, in this study we focus on thin calcitic layers within the Clachtoll formation and younger Poll a' Mhuilt member that may represent stromatolites, or stromatolite like deposits. Whilst recent work has cast doubt on the biogenic origin of these calcite layers, suggesting they may be either evaporitic or detrital in origin, we believe that much of the petrographic and isotope evidence is equivocal. Focusing on large scale morphology, sedimentary structures, micro-fabrics and mineralogy we present new evidence for the biogenicity of these deposits. A key difficulty is resolving both diagentic (pressure solution, stylolite development and neomorphism) and later grain growth fabrics associated with low grade metamorphism from unaltered fabrics and grains. In combination with bulk ($\delta^{13}C$ and $\delta^{18}O$) and clumped isotope (Δ_{47}) studies we find that whilst the Stoer Group has undergone low grade metamorphism with maximum temperatures of ca. 120^{o}C the isotope system has remained closed with respect to exchange with diagenetic and metamorphic fluids. The implication is that the very depleted $\delta^{18}O$ values for the calcites of -18‰$_{VPDB}$ are characteristic of the original environmental conditions. Meteoric water values would need to be as low as -15 to -20‰$_{VSMOW}$ for precipitation of the calcite at ambient Earth surface temperatures. This is *prima facie* evidence that the deposits are terrestrial and not marine and at face value also implies cold conditions with isotopically depleted rainfall. We cannot rule out, however, that precipitation sourced from a global ocean that is significantly depleted in ^{18}O as suggested by some models may contribute to explaining the very depleted isotope signatures and apparent low temperatures.