

## Isotope microanalyses of 2.72 Ga organic matter: metabolism *versus* diagenesis *versus* matrix effects

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Isotope heterogeneities in organic matter (OM) may occur at a sub-mm scale due to preservation of precursors with distinct metabolic fractionations, variable diagenetic alteration, and migration of OM. These are difficult to distinguish due to the small size of OM particles and matrix effects induced by Secondary Ion Mass Spectrometry (SIMS). We investigated  $\delta^{13}\text{C}$  VPDB values of OM in 2.72 Ga stromatolites of the Tumbiana Fm (Australia), using SIMS with analytical spots 1–6  $\mu\text{m}$  dia. and multicollection of  $^{13}\text{C}^-$ ,  $^{12}\text{C}^-$  and  $^{13}\text{CH}^-$ . Bias caused by variable H/C was corrected using standards. No bias is caused by matrix quartz. Mixtures of chlorite shift negatively the  $\delta^{13}\text{C}$  of associated OM, possibly through recombination of chloritic H with  $\text{C}^-$ . We cut off high-uncertainty data with countrates < 25% of the signal on pure OM and selected larger particles between chlorites with  $^{13}\text{CH}^-/^{13}\text{C}^- < 0.085$ , the maximum value recorded in OH-free minerals.  $\delta^{13}\text{C}_{\text{OM}}$  in quartz and between chlorites ranges between  $-56$  and  $-51 \pm 1.1\%$  (average:  $-54\%$ ). Mixture of OM and calcite in SIMS spots shifts positively the measured  $\delta^{13}\text{C}$ . A mixing curve intercepting the measured  $\delta^{13}\text{C}$  of OM-rich spots and that of pure calcite allowed estimation of the  $\delta^{13}\text{C}_{\text{OM}}$  in micrometric OM globules ( $-65$  to  $-52 \pm 2\%$ , average  $-58.5\%$ ). Unlike OM in chlorite/quartz, these globules display high organic S concentrations that combined with the extremely low  $\delta^{13}\text{C}_{\text{OM}}$  suggest anaerobic consortia of methanotrophic archaea with sulfate-reducing bacteria. Finally, pyrobitumen nodules ( $\delta^{13}\text{C}_{\text{VPDB}}$ :  $-48$  to  $-39 \pm 0.7\%$ ) suggest that the relatively higher  $\delta^{13}\text{C}$  OM (up to  $-30\%$ ) of some Tumbiana stromatolites may include migrated OM.