Determination of $n(^{13}C)/n(^{12}C)$ isotope ratios by MC-ICPMS and IRMS for providing improved $R(^{13}C/^{12}C)$ value of the zero-point of the VPDB isotope delta scale

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Reporting $^{13}C/^{12}C$ isotope ratios

Variations in $^{13}C/^{12}C$ isotope ratios are commonly reported as delta values (in ‰) on the international scale VPDB-LSVEC:

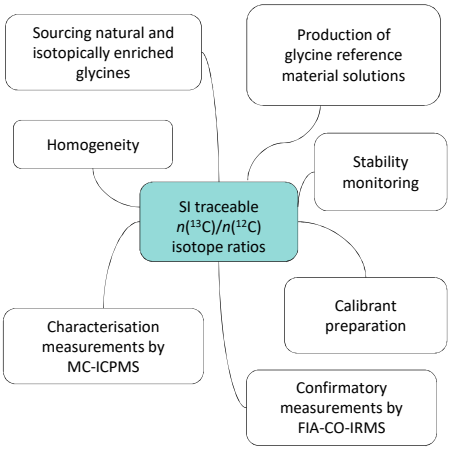
$$\delta^{13}C_{VPDB} = \frac{{}^{13}R_{sample}}{{}^{13}R_{VPDB}} - 1$$

While carbon isotope delta values relative to VPDB can be obtained with very small uncertainties, maintenance of the VPDB scale itself is challenging as it is based upon artefacts with exactly assigned isotope delta values..

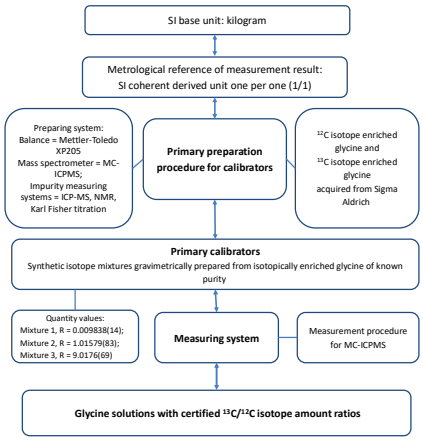
Linking the VPDB isotope delta scale to the International System of Units (SI) is a sustainable solution ensuring accuracy and metrological traceability of measurement results.

To enable traceability to SI, new and improved methods of $n(^{13}C)/n(^{12}C)$ measurements by gas source isotope ratio mass spectrometry (IRMS) and multicollector inductively coupled plasma mass spectrometry (MC-ICPMS) have been developed at LGC.

Experimental design

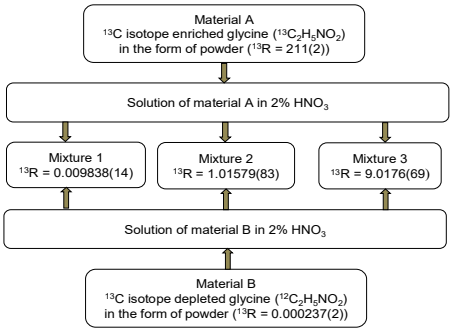


Traceability to SI units



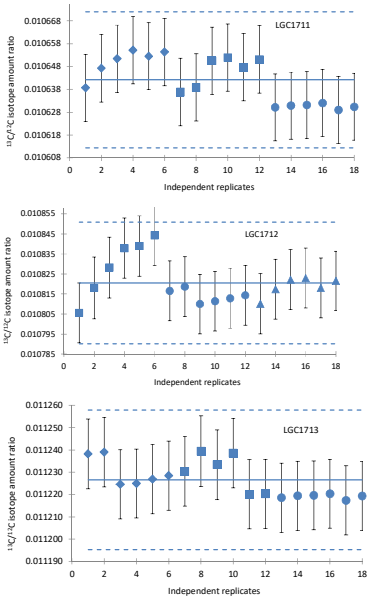
Preparation procedure for calibrators of $R(^{13}C/^{12}C)$

Parent isotopically enriched glycines were weighed and brought into solution and then mixed with each other in different proportions.



Measurement results

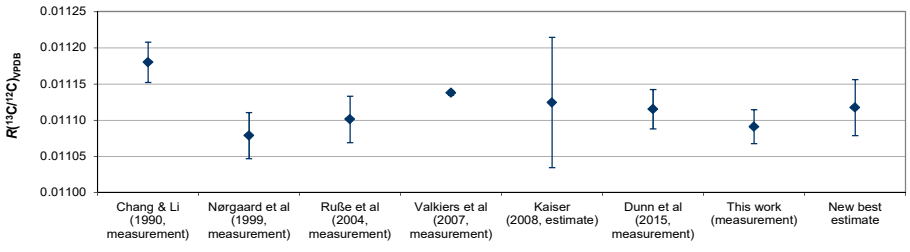
$n(^{13}C)/n(^{12}C)$ isotope ratios determined for the glycine CRM LGC171-KT in characterisation study. Uncertainty bars are U_c (k=1); solid and dotted lines are mean values and U_{exp} (k=2), respectively.



Certified values of absolute carbon isotope ratios and indicative $\delta^{13}C_{VPDB\text{-}LSVEC}$ values of LGC171-KT. Uncertainties in parentheses are U_{exp} (k=2).

Solution	$n(^{13}C)/n(^{12}C)$ ratio	$\delta^{13}C_{VPDB\text{-}LSVEC}$ values, ‰
LGC1711	0.010642(30)	-42.22(0.34)
LGC1712	0.010821(30)	-24.66(0.24)
LGC1713	0.011227(32)	+12.55(0.22)

Re-determination of $R(^{13}C/^{12}C)_{VPDB}$



Comparison of $R(^{13}C/^{12}C)_{VPDB}$ values previously reported in the literature together with a new best estimate. Error bars show the expanded uncertainties. The reference materials certified at LGC realise an absolute isotope ratio for VPDB, $R(^{13}C/^{12}C)_{VPDB}$, through regression of the $n(^{13}C)/n(^{12}C)$ against $\delta(^{13}C/^{12}C)_{VPDB}$ values. Examining all published values for $R(^{13}C/^{12}C)_{VPDB}$, including our most recent results, allows a better estimation of this quantity than has previously been achievable.

Conclusions

Improved methodology has been developed and successfully applied to characterization and certification of a new glycine reference material, CRM LGC171-KT. The certified $R(^{13}C/^{12}C)$ values of the material are traceable to the SI base units in the most direct way through calibration of the mass spectrometer with calibrators prepared from well characterised isotopically enriched glycines.

Isotope amount ratios $n(^{13}C)/n(^{12}C)$ obtained have enabled provision of a new estimate of $R(^{13}C/^{12}C)$ value of the zero-point of the VPDB isotope delta scale.

It is expected that a close partnership between research groups within recently funded JRP Stellar project will accelerate further development of the methdology to enable a more reliable link between the relative carbon isotope delta scale and the SI.

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