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The IAEA carbonate reference materials aimed at the VPDB scale realization with low uncertainty.

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The stable isotope scales of the light elements (H, C, O, S) are artefact-based (related to a primary reference material) and their practical realisation is based on several refence materials (RMs) traceable to the primary RM on a respective delta-scale. NBS19 carbonate, the primary RM for the VPDB scale introduced in 1987, exhausted in 2012, and its replacement was not available for several years. In 2016, IAEA-603 carbonate (replacement for NBS19) was released as the new primary RM having been carefully calibrated versus the remaining NBS19. The IAEA-603 uncertainty in δ13C and δ18O for the first batch (5200 ampoules produced) is ±0.010 ‰ and ±0.040 ‰ respectively (1-sigma level); the homogeneity assessment is the major component of total uncertainty which is limited by the best mass-spectrometer performance and the method (carbonate-acid reaction) reproducibility.

In 2015, monitoring of LSVEC (formerly the second scale-anchor on the VPDB scale) detected variable drifts in its δ13C value and therefore the use of LSVEC as RM for δ13C was discontinued. It was recognised that a replacement for LSVEC is needed for normalization of the δ13C measurement results, also to address the strict uncertainty requirements for δ13C observations in atmospheric CO2 and methane (≤0.01 ‰ and ≤0.02 ‰ correspondingly). Similar to IAEA-603, any new RMs will address the technical requirements for RMs laid out by ISO Guide 35: 2017 including (i) RM batch production and batch characterisation; (ii) homogeneity and stability assessment of the final product (RMs sealed off in 0.5 g ampoules) and (iii) value and uncertainty assignment based on the metrological traceability. Three new carbonate RMs are in preparation at the IAEA; the uncertainty in δ13C for all three materials due to RM' homogeneity is already confirmed at ≤0.01 ‰ (on 10 mg aliquots), which is at the limit of the best modern mass-spectrometers. The isotopic characterisation of these new carbonate RMs is in progress; they should be released in 2020.

Together with IAEA-603, the three new RMs will provide a reliable realization of the VPDB scale with the lowest possible uncertainty. With these RMs users can (i) select RMs in a suitable δ13C range, (ii) detect any potential drift of RMs including the behaviour of daily lab-standards and (iii) detect any potential problem in applying the 17O correction at end-user laboratories. In conclusion, these new reference materials will allow laboratories worldwide to establish metrological comparability for decades.