Evaluation of the "scrambling effect" caused by EI sources for clumped isotope analysis

Introduction

The "clumped isotope" technique has recently been developed mainly for geochemistry applications and has been recently discussed in application notes 021 & 024. The fundamental principle is to measure multiply-substituted isotopologues in gas molecules at natural abundance to very high, <10 per meg (one part in a million), precision as quickly as possible. This is a very demanding technique which requires a large instrument dynamic range as well as optimised gas handling and a highly stable Electron Impact (EI) ionisation source designed for high sensitivity but minimum "scrambling" of the reference/sample

Source Scambling Effect

Physical processes like fragmentation and/or recombination occurring within an EI source will generate isotopic fractionation. Conventional IRMS techniques usually take this into account by comparing sample vs reference gases assuming they are both affected in the same way.

In 2011, Dennis *et al*. investigated this topic and organised an inter-laboratory comparison for clumped isotope measurements. The authors suggest EI source reactions result in randomisation of isotopic ordering in the molecules and thus the effect will depend upon how far the sample or reference molecule is from a stochastic distribution. That means the standard and the sample may not be affected in the same way which might generate biases in Δ47 measurements. Dennis *et al*. propose a way to account for this effect and suggest how to correct for it.

Results

In 2011 an IsoPrime100 system configured for clumped isotope measurements was installed in the *'Laboratoire des Sciences du Climat et de l'Environement' (LSCE)*, Paris, France. Preliminary experiments have been performed and are reported in Fig. 1 relative to the data from Dennis *et al*. Dennis *et al*. (2011) compared data from four different laboratories for CO2 equilibrated at different temperatures. The data presented here represents Δ47 of CO2 equilibrated at 1000°C versus Δ47 from CO2 equilibrated at 22°C. The LSCE IsoPrime100 is a compact, benchtop instrument while all others are large radius instruments.

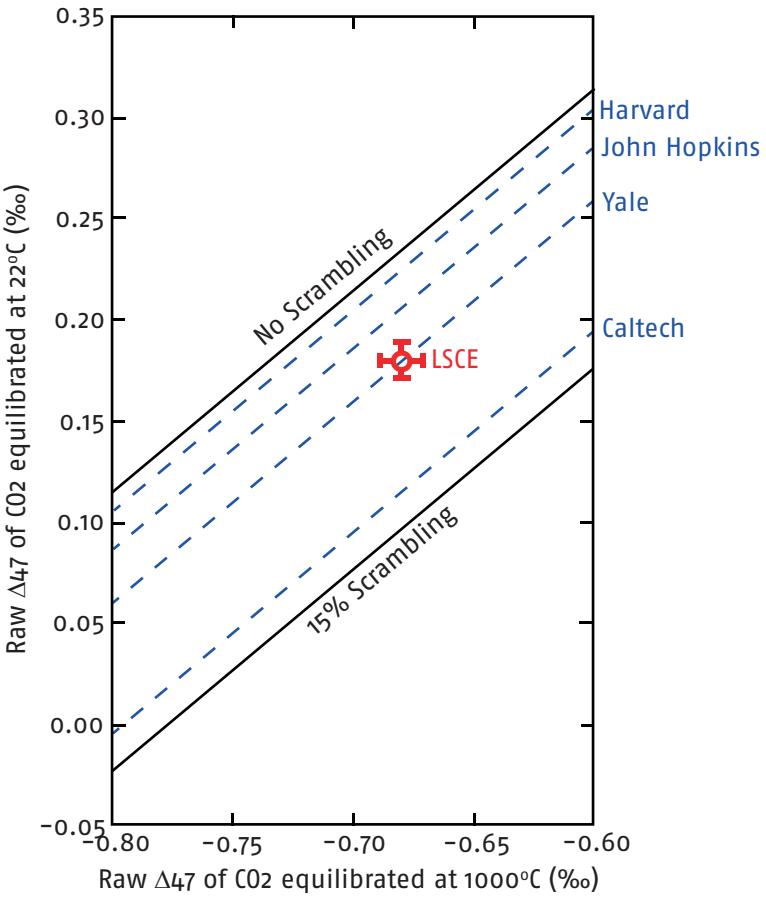

Fig. 1: Comparison between IsoPrime measurements and inter laboratory data from Dennis et al.2011

Conclusions

These results demonstrate the capacity for the IsoPrime100 to match competitive (large radius) systems for this "clumped isotope" analytical technique. In particular this illustrates the design and build quality of the IsoPrime100 EI source which is of paramount importance for this application. If we combine this performance with the unrivalled capacity for the MultiPrep system to automatically prepare CO2 from carbonate samples Isoprime Ltd. is able to offer the scientific community an extremely powerful tool to investigate this new field of "clumped isotopes".

References

Dennis K.J., Adkins J., Affek, H.P., Passey B.H., Schrag D.P. and Eiler J. M., (2011): Defining an absolute reference frame for clumped isotope studies of CO2. Geochemica Cosmochemica Acta 75, 7117-7131.

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