

# PALEOENVIRONMENTAL CHARACTERIZATION OF THERMALLY MATURE ORGANIC MATTER USING A NEW PYROLYSIS-IRMS METHOD

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## Introduction

The organic matter (OM) type, the paleoenvironmental conditions (cf. Sofer, 1984) as well as thermal degradation control the isotopic composition of OM. Here we aim at presenting a novel analytical technique and demonstrating the potential to enhance the understanding of the maturation-expulsion process for OM from different paleoenvironments. A Py-GC-IRMS method was developed to monitor these changes during Rock Eval type pyrolysis (cf. Espitalié et al. 1985), while simultaneously recording pyrograms to obtain standard-compatible S1 and S2 peaks. In combination with a standard elemental analyser IRMS system we are able to fully characterize the inert, refractory and bitumen components of OM isotopically (carbon) thereby being able to see depositional control as well as changes imposed by maturation and potentially expulsion. We use an automated cryo-trapping device, which allows us to sequentially subsample defined portions of products over the entire pyrolysis. Each subsample is subsequently transferred to the IRMS for carbon isotopic measurements. In addition, the cryotrap serves as a sample peak focus, enabling robust and reproducible results even at fast heating rates.

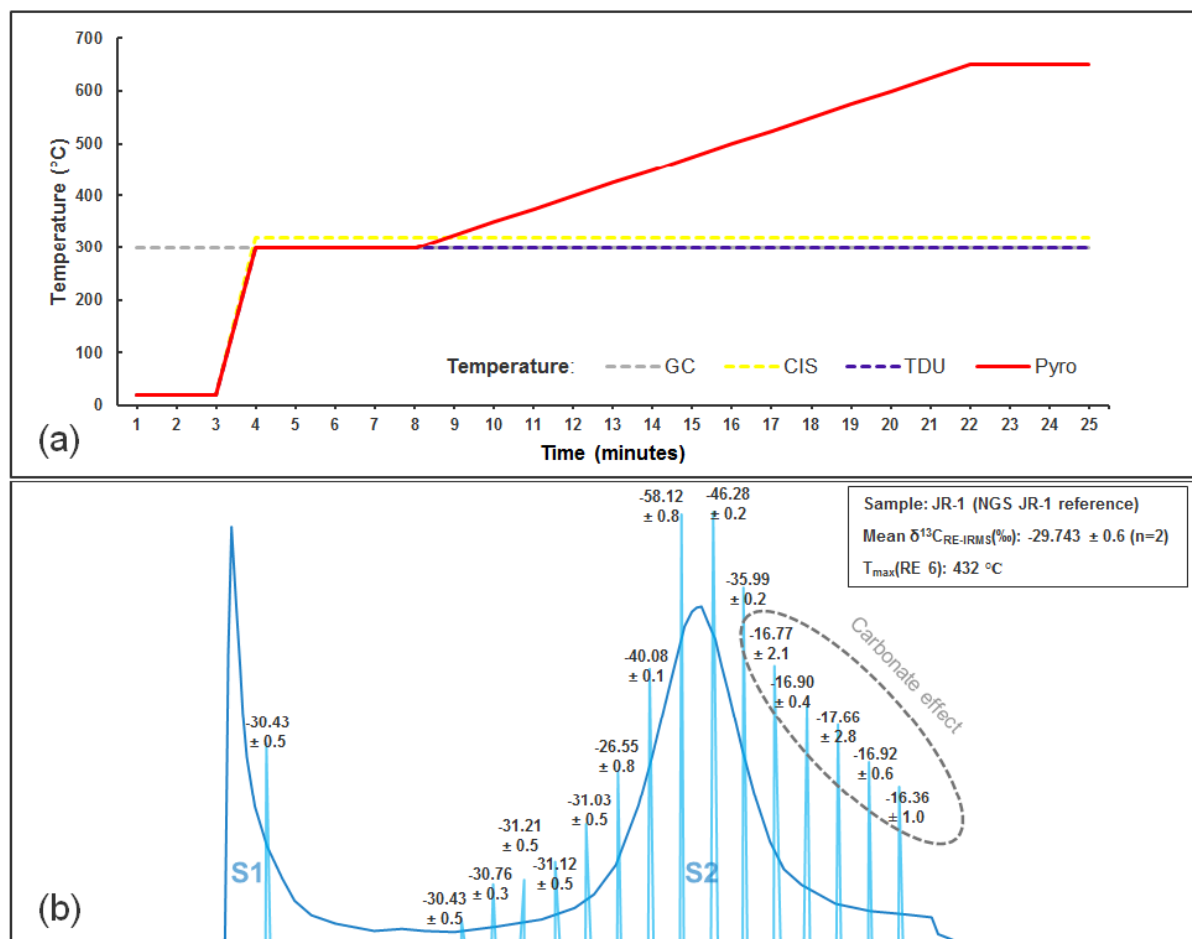
## Method

The sample material is packed into quartz tubes sealed with quartz wool, and automatically lowered into the pyrolysis unit by a Gerstel multipurpose sampler equipped with a gripper. The Py-GC-IRMS analyses are performed on an Agilent 7890B gas chromatograph equipped with a Gerstel CIS 6 with TDU and pyrolyser unit. The sample stream is conducted through a 4 m, 0.250 mm i.d. fused silica transfer line into an Agilent five port CFT purged splitter unit. The flow into the TCD, FID and IRMS (Isoprime 100 and Isoprime GC 5) detectors are controlled by restriction. A cryotrap, consisting of a Dewar flask filled with liquid nitrogen and a coiled fused silica column, was fitted between the combustion oven and the IRMS detector. The coiled column is fixed on a computer controlled pneumatic piston, which lowers the column into the Dewar flask (product trap) and subsequently pulls it out for product release. In contrast to the Rock Eval method described in Espitalié et al. (1985) the pyrolysis unit and the CIS system are kept at room temperature when the sample is lowered into the inlet. A detailed summary of the temperature program for each component is indicated in Figure 1a. During the first pyrolysis step, CO<sub>2</sub> eluting from the combustion oven is trapped and released after the isothermal phase. During the second phase of pyrolysis (S2) the CO<sub>2</sub> eluting from the combustion oven is stepwise trapped approximately every 25 °C of temperature increase (Figure 1b).

## Results

Organic-rich rocks from different locations and also a Cenozoic core section from Svalbard comprising different facies and thermal maturities have been analysed with the new Py-GC-IRMS method. The range of isotopic values observed differs as a function of the source and the maturity of OM. Especially the degree of water column anoxia during organic

matter deposition seems to have a significant influence on the carbon isotopic composition of different temperature step subsamples released from the cryotrap, implying that they may represent different compound groups. Carbon isotope ratios of pyrolysate subsamples deviate significantly from the bulk isotope composition of all samples, where coals generally show minor fractionations compared to marine or lacustrine shales..



**Figure 1** (a) Diagram of the temperature program of each device during the pyrolysis. (b) Results for the NGS JR-1 (Norwegian Geochemical Standard). S1 and S2 are indicated by the dark blue line (FID-Py-GC). The IRMS cryo-trap pulses (light blue) show a similar response to thermal degradation when compared with the FID record. The carbonate from this sample was not removed, resulting in a heavy isotope record at the end of the run. The data points are given in  $\delta^{13}C$  (‰, V-PDB).

## References

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