

Fig. S1. Hydrothermal chert veins of the ca. 3.5 Ga Dresser Formation (Pilbara Craton, Western Australia). **(a)** Hydrothermal chert veins of the Dresser Formation (ridges, see arrows) forming large-scale networks in their host basalts. **(b)** Hydrothermally altered footwall basalts exhibiting pillow structures (arrows); hammer for scale (red circle). **(c, d)** Hydrothermal chert veins of the Dresser Formation penetrating komatiitic footwall basalts in a recent cut wall of the abandoned Dresser Mine (persons for scale). The analysed hydrothermal chert vein occurs adjacent to the one shown in **(d)**.

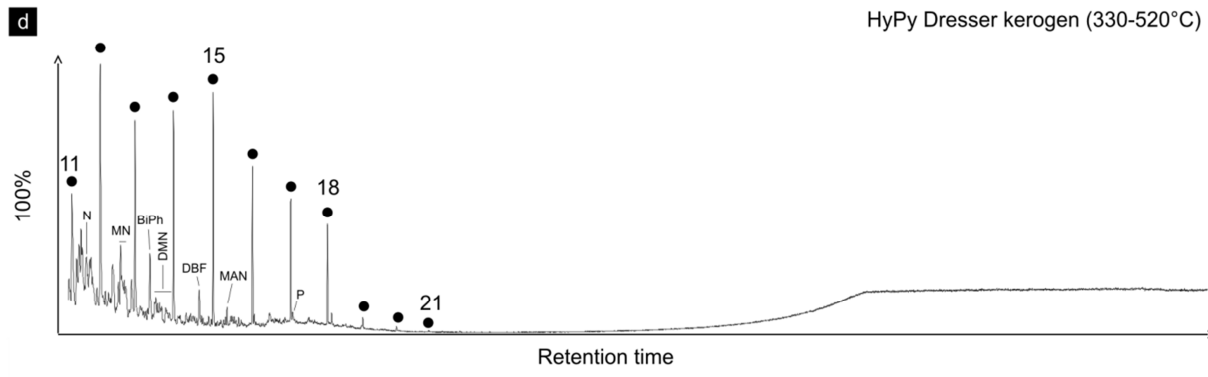
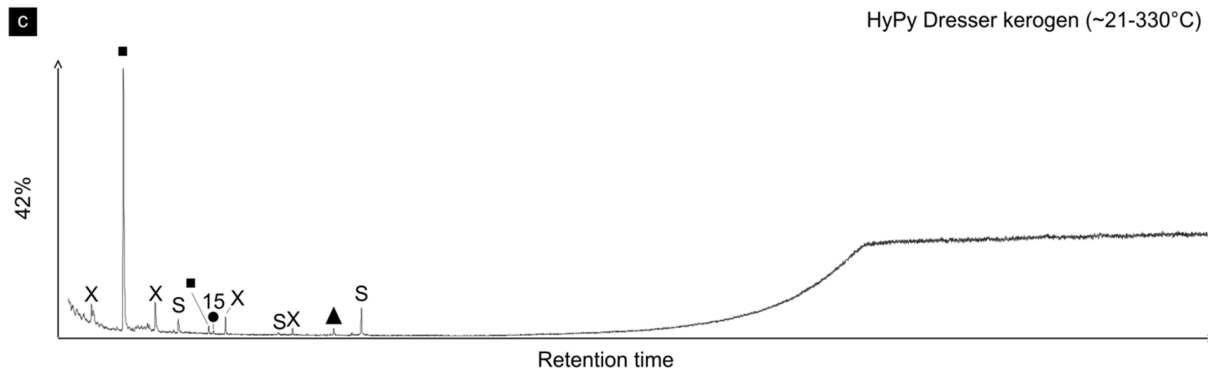
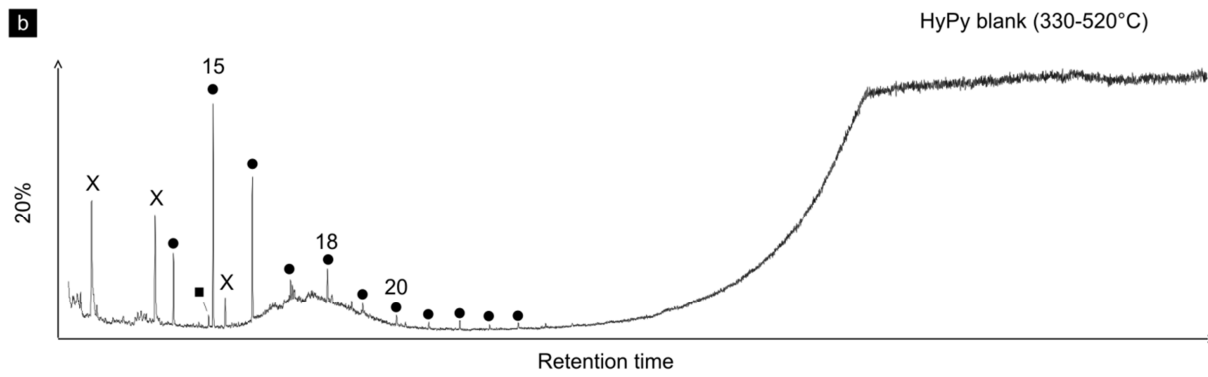
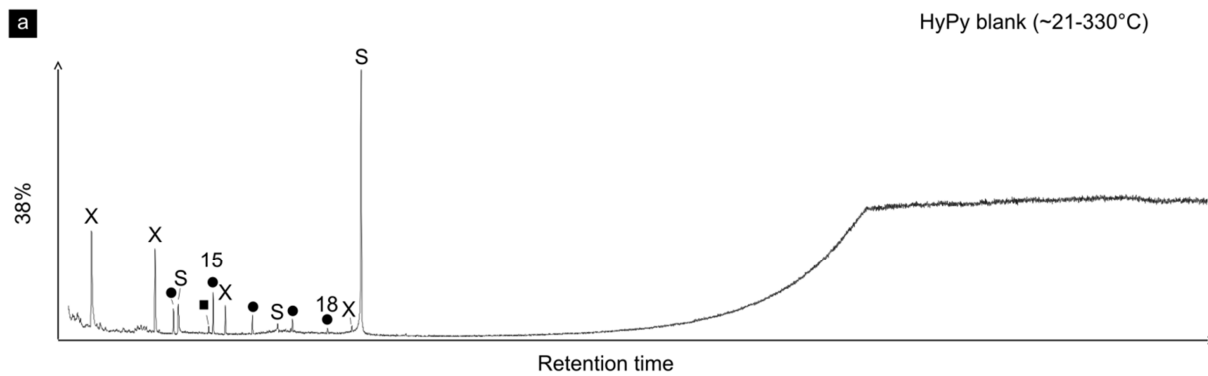


Fig. S2. Total ion current chromatograms. Low temperature (**a**) and high temperature (**b**) HyPy products of the analytical blank (combusted sea sand) obtained prior to HyPy of the Dresser kerogen. Low temperature (**c**) and high temperature (**d**) HyPy products of the Dresser kerogen. Compounds detected in (**a–c**) represent background contamination and/or artefacts. Note that high temperature HyPy of the Dresser kerogen yielded significantly higher amounts of products with a distinctly different distribution pattern. Black dots: *n*-alkanes (numbers refer to carbon chain lengths); triangle: phthalic acid; N: naphthalene; MN: methylnaphthalenes; BiPh: 1,1'-biphenyl; DMN: dimethylnaphthalenes; MAN: methylacenaphthenes; P: phenanthrene; crosses: siloxanes (GC column or septum bleeding); squares: phenols; S: sulphur.

Note: Percentage values given on the vertical axes of chromatograms (**a–c**) relate peak intensities to chromatogram (**d**) (HyPy Dresser kerogen, 330–520°C).

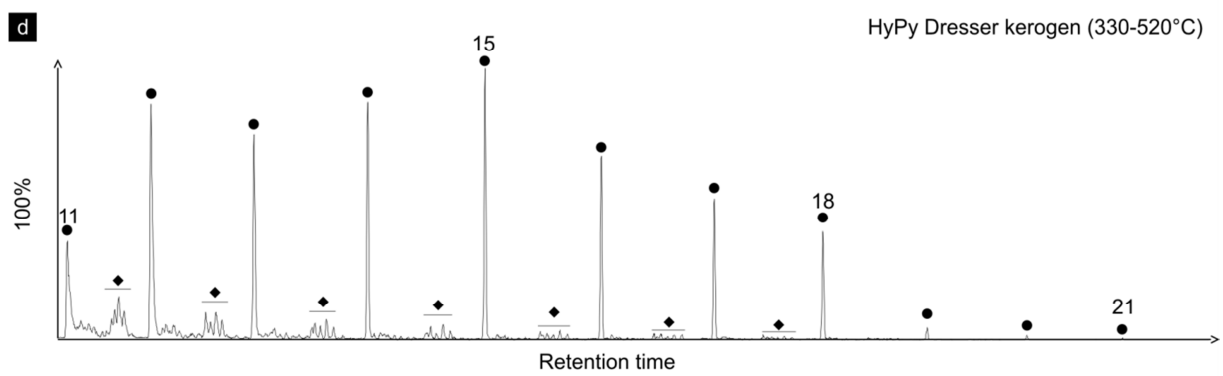
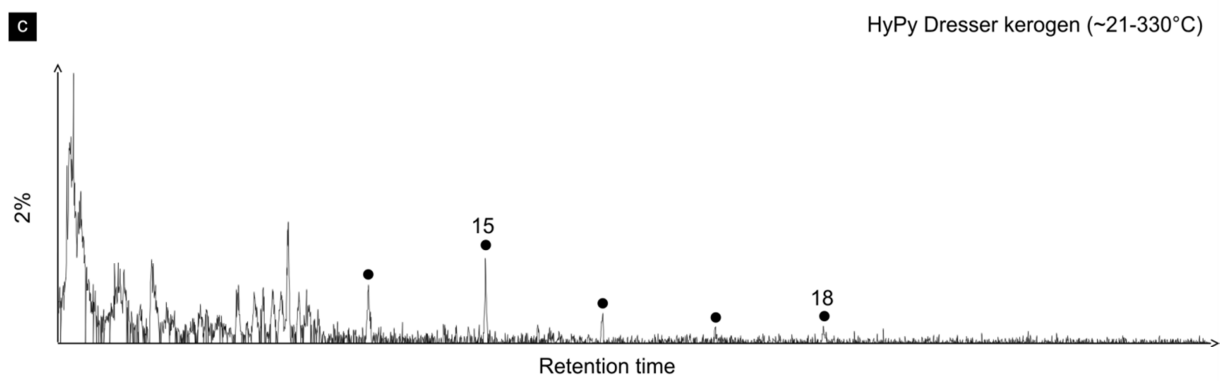
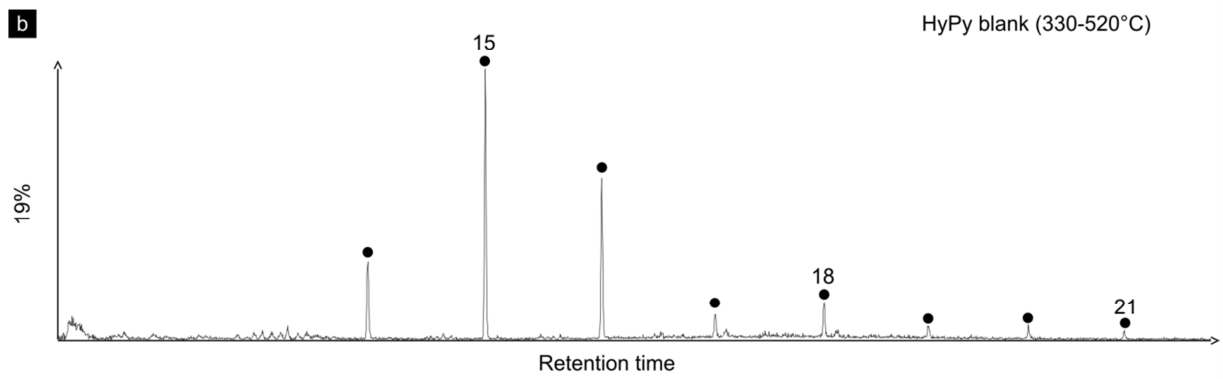
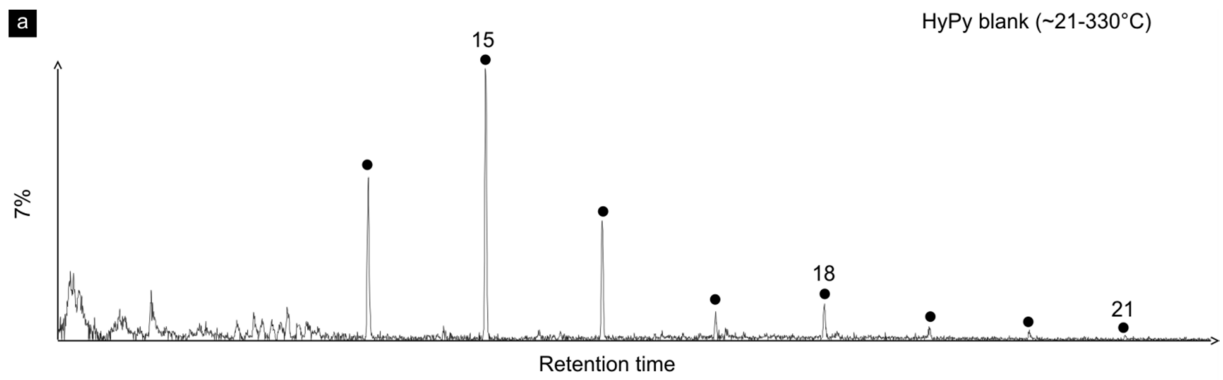


Fig. S3. Partial ion chromatograms selective for alkanes (m/z 85). Low temperature (**a**) and high temperature (**b**) HyPy products of the analytical blank (combusted sea sand) obtained prior to HyPy of the Dresser kerogen. Low temperature (**c**) and high temperature (**d**) HyPy products of the Dresser kerogen. High temperature HyPy produced the highest yields of n -alkanes and minor clusters of isomeric monomethylalkanes (diamonds in **d**). The n -alkanes in the high temperature pyrolysate of the Dresser kerogen (**d**) furthermore exhibit a distinct distribution different to those observed in (**a-c**). All compounds detected in (**a-c**) are considered to represent background contamination. Black dots: n -alkanes (numbers refer to carbon chain lengths).

Note: Percentage values given on the vertical axes of chromatograms (**a-c**) relate peak intensities to chromatogram (**d**) (HyPy Dresser kerogen, 330–520°C).

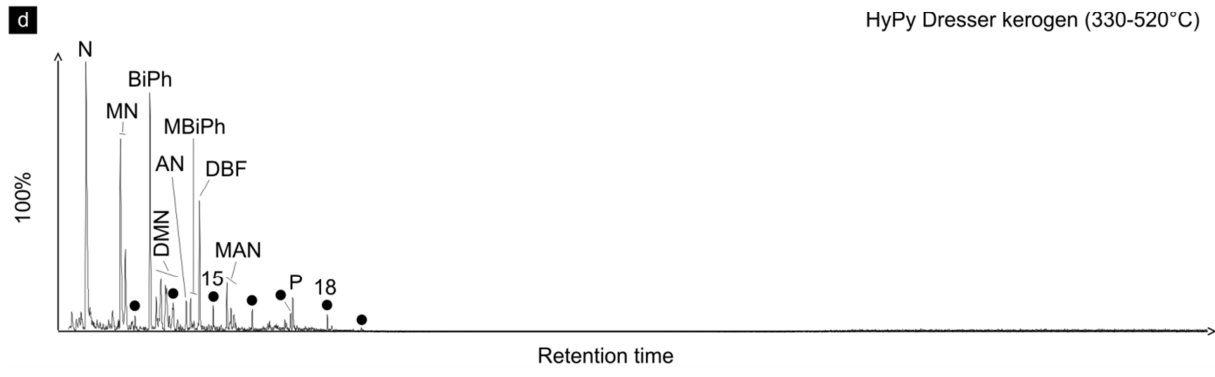
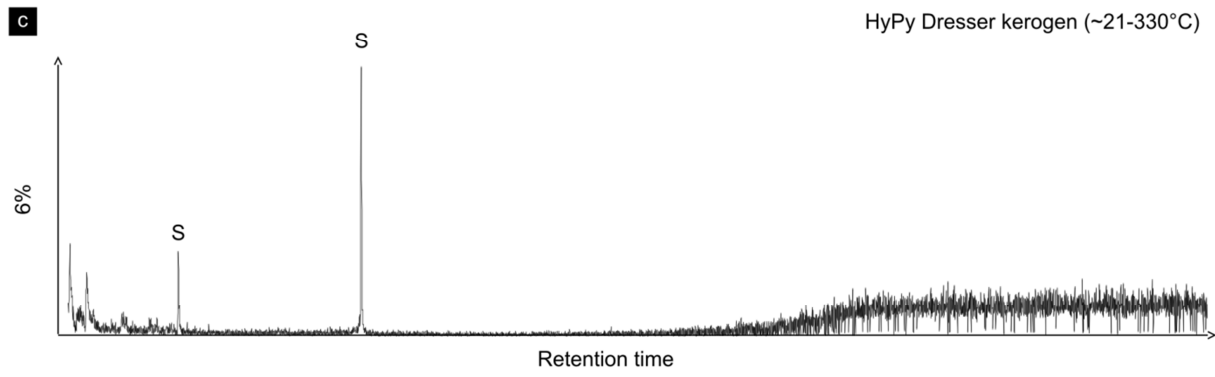
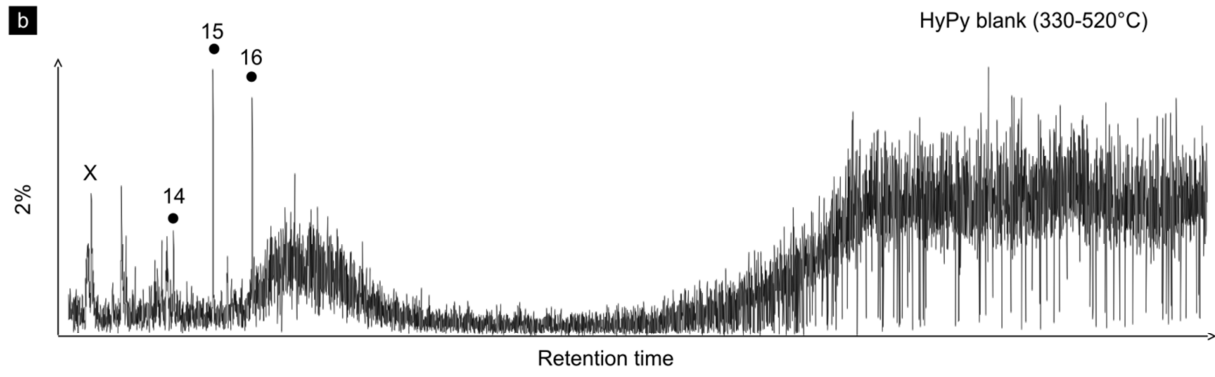
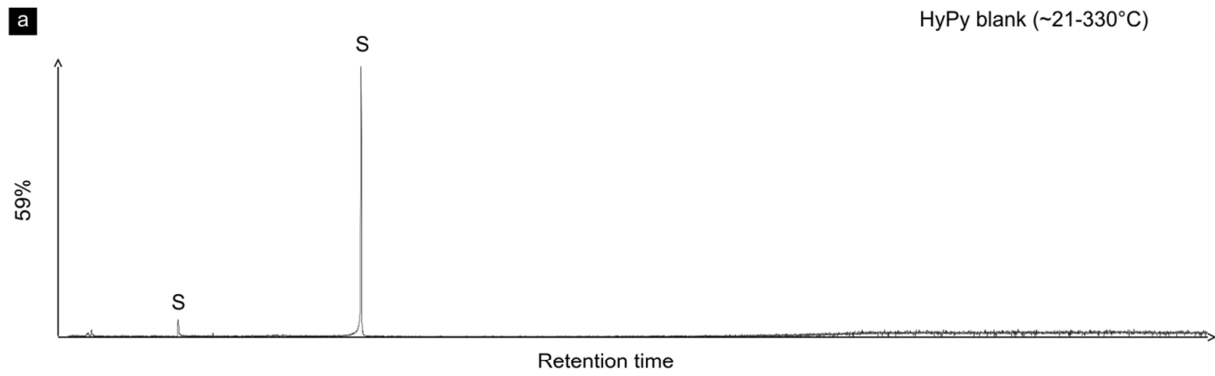


Fig. S4. Ion chromatograms selective for aromatic hydrocarbons (m/z 128, 142, 154, 156, 168, 178). Low temperature (a) and high temperature (b) HyPy products of analytical blank (combusted sea sand) obtained prior to HyPy of the Dresser kerogen. Low temperature (c) and high temperature (d) HyPy products of the Dresser kerogen. Note that high temperature HyPy of the Dresser kerogen yielded a variety of aromatic hydrocarbons, which are orders of magnitudes lower or absent in all other pyrolysates. Black dots: *n*-alkanes (numbers refer to carbon chain lengths); N: naphthalene; MN: methylnaphthalenes; BiPh: 1,1'-biphenyl; DMN: dimethylnaphthalenes; AN: acenaphthene; MBiPh: methylbiphenyls; DBF: dibenzofuran; MAN: methylacenaphthenes; P: phenanthrene; crosses: siloxanes (GC column or septum bleeding); S: elemental sulphur (likely derived from the sulfidic catalyst).

Note: Percentage values given on the vertical axes of chromatograms (a–c) relate peak intensities to chromatogram (d) (HyPy Dresser kerogen, 330–520°C).

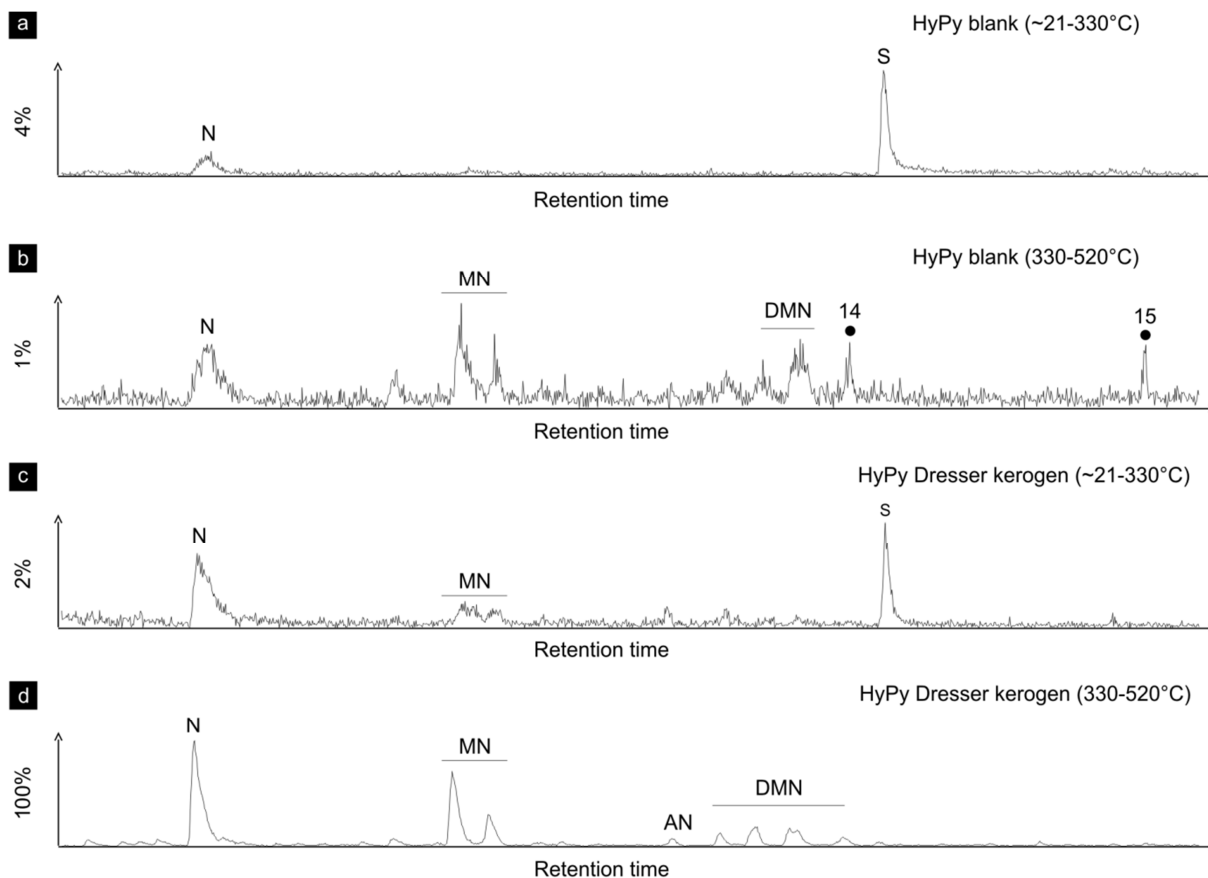


Fig. S5. Partial ion chromatograms selective for (dimethyl-, methyl-)naphthalenes (m/z 128, 142, 156). Low temperature (a) and high temperature (b) HyPy products of the analytical blank (combusted sea sand) obtained prior to HyPy of the Dresser kerogen. Low temperature (c) and high temperature (d) HyPy products of the Dresser kerogen. High temperature HyPy of the Dresser kerogen yielded naphthalene (N), methyl-naphthalenes (MN), dimethylnaphthalenes (DMN) and acenaphthene (AN), which are orders of magnitudes lower or absent in all other pyrolysates. Black dots: *n*-alkanes (numbers refer to carbon chain lengths); S: elemental sulphur (likely derived from the sulfidic catalyst). Note: Percentage values given on the vertical axes of chromatograms (a–c) relate peak intensities to chromatogram (d) (HyPy Dresser kerogen, 330–520°C).

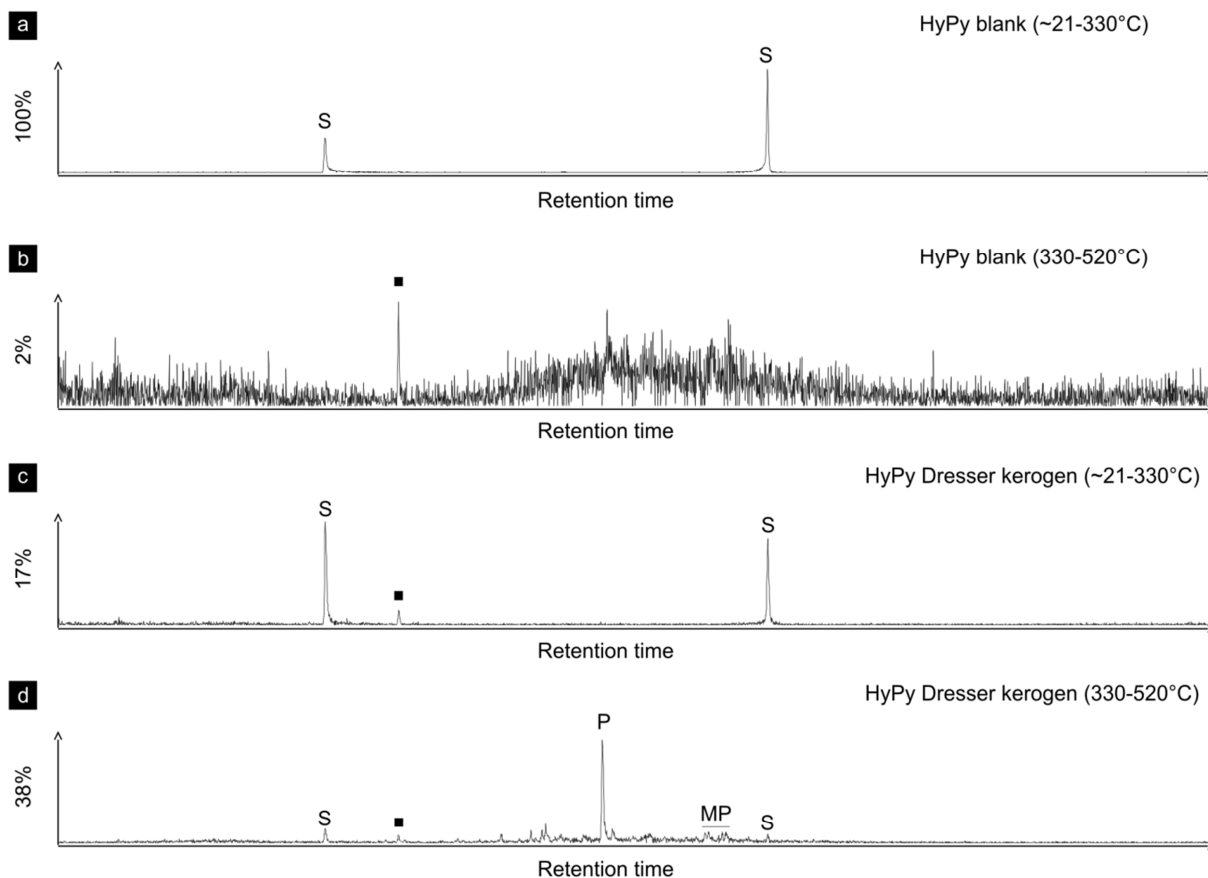


Fig. S6. Partial ion chromatograms selective for (methyl-)phenanthrenes (m/z 178, 192). Low temperature (**a**) and high temperature (**b**) HyPy products of the analytical blank (combusted sea sand) obtained prior to HyPy of the Dresser kerogen. Low temperature (**c**) and high temperature (**d**) HyPy products of the Dresser kerogen. Phenanthrene (P) and traces of methylphenanthrenes (MP) were only present in the high temperature HyPy pyrolysate of the Dresser kerogen. Squares: phenols; S: elemental sulphur (likely derived from the sulfidic catalyst).
 Note: Percentage values given on the vertical axes of chromatograms (**b–d**) relate peak intensities to chromatogram (**a**) (HyPy blank, ~21–330°C).

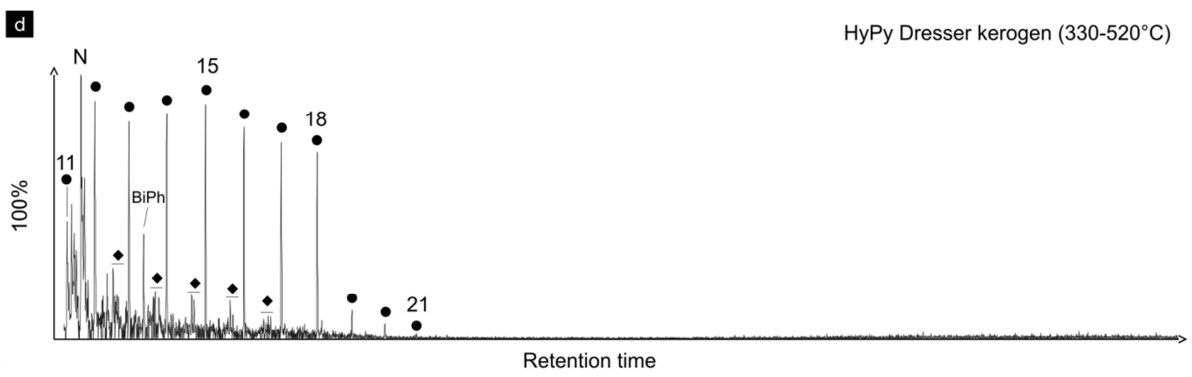
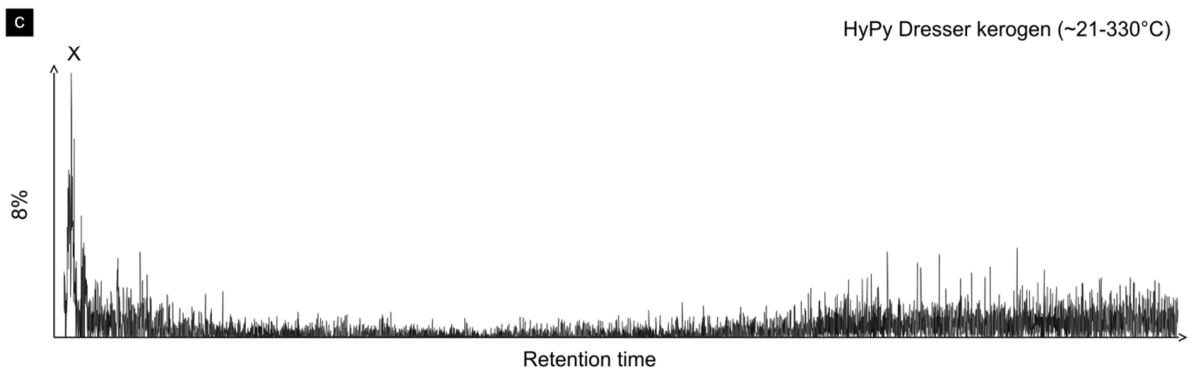
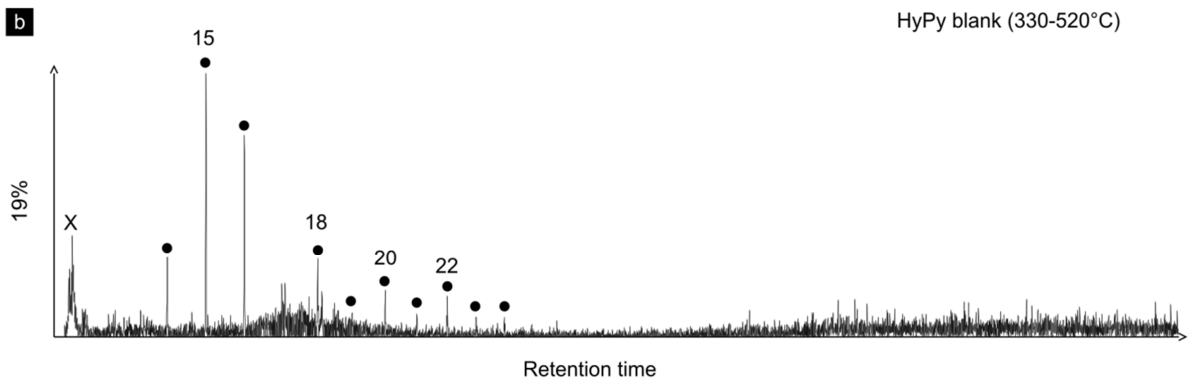
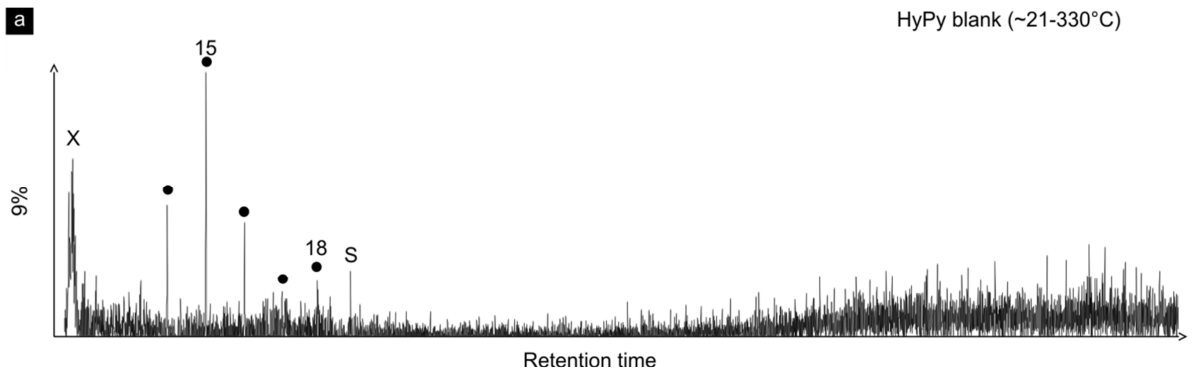


Fig. S7. Ion chromatograms selective for branched alkanes with quaternary carbon centres (BAQCs; m/z 127). Low temperature (**a**) and high temperature (**b**) HyPy products of the analytical blank (combusted sea sand) obtained prior to HyPy of the Dresser kerogen. Low temperature (**c**) and high temperature (**d**) HyPy products of the Dresser kerogen. Compounds detected in (**a–c**) represent background contamination and/or artefacts. Note the absence of BAQCs in all pyrolysates. Black dots: *n*-alkanes (numbers refer to carbon chain lengths); diamonds: monomethylalkanes; N: naphthalene; BiPh: 1,1'-biphenyl; crosses: siloxanes (GC column or septum bleeding); S: elemental sulphur (likely derived from the sulfidic catalyst). Note: Percentage values given on the vertical axes of chromatograms (**a–c**) relate peak intensities to chromatogram (**d**) (HyPy Dresser kerogen, 330–520°C).

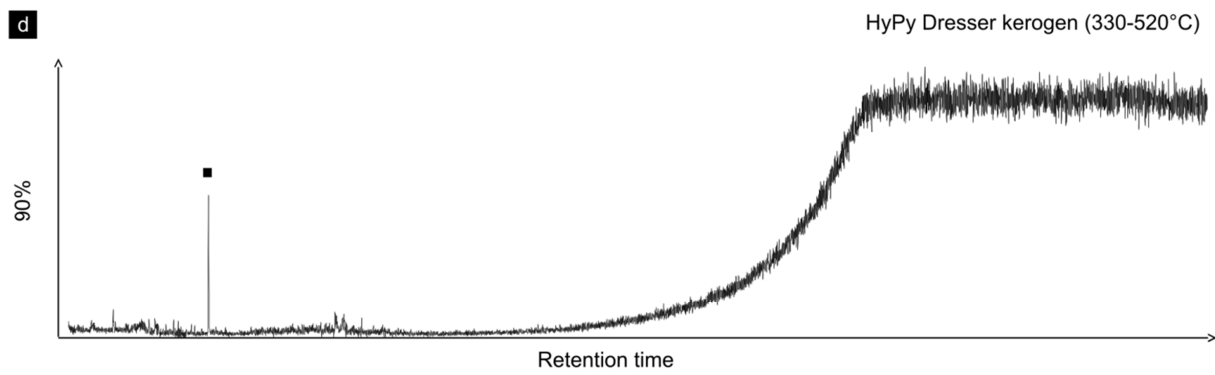
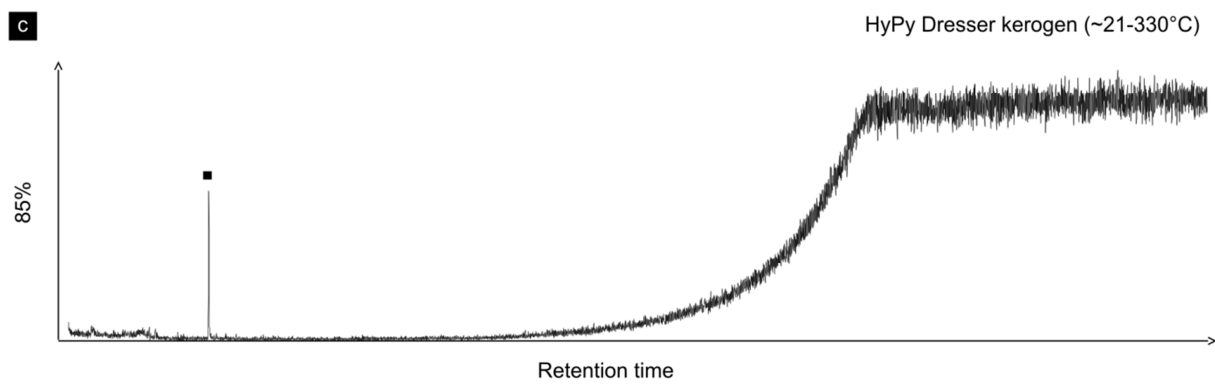
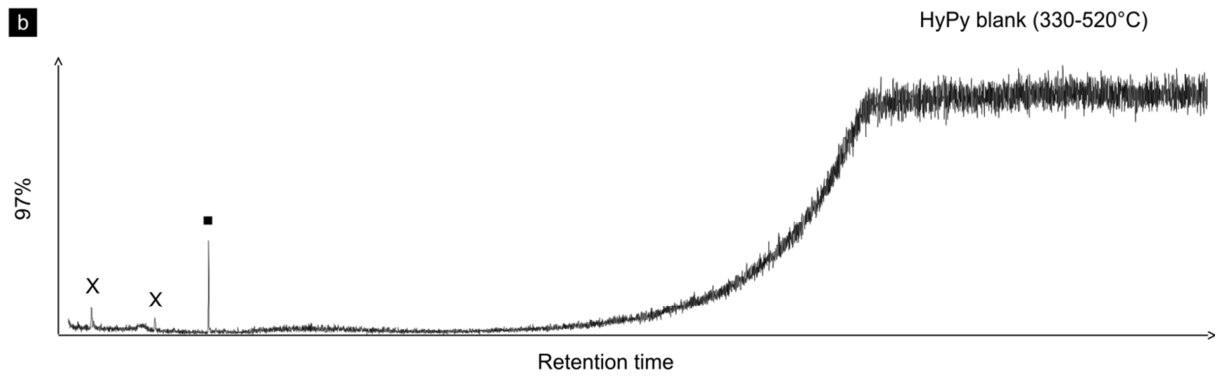
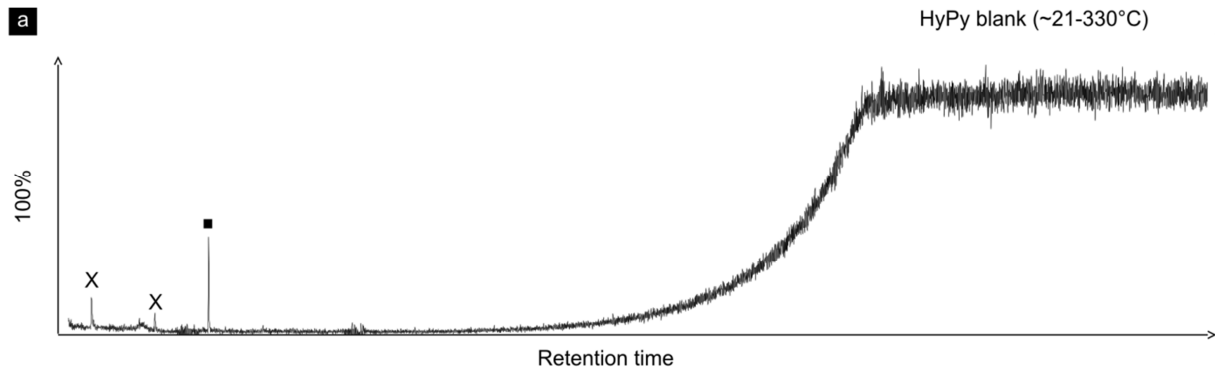


Fig. S8. Ion chromatograms selective for hopanes (m/z 191). Low temperature (**a**) and high temperature (**b**) HyPy products of the analytical blank (combusted sea sand) obtained prior to HyPy of the Dresser kerogen. Low temperature (**c**) and high temperature (**d**) HyPy products of the Dresser kerogen. All compounds in (**a–d**) represent background contamination and/or artefacts. Note the absence of hopanes in all pyrolysates. Crosses: siloxanes (GC column or septum bleeding); squares: phenols.

Note: Percentage values given on the vertical axes of chromatograms (**c–d**) relate peak intensities to chromatogram (**a**) (HyPy blank, ~21–330°C).

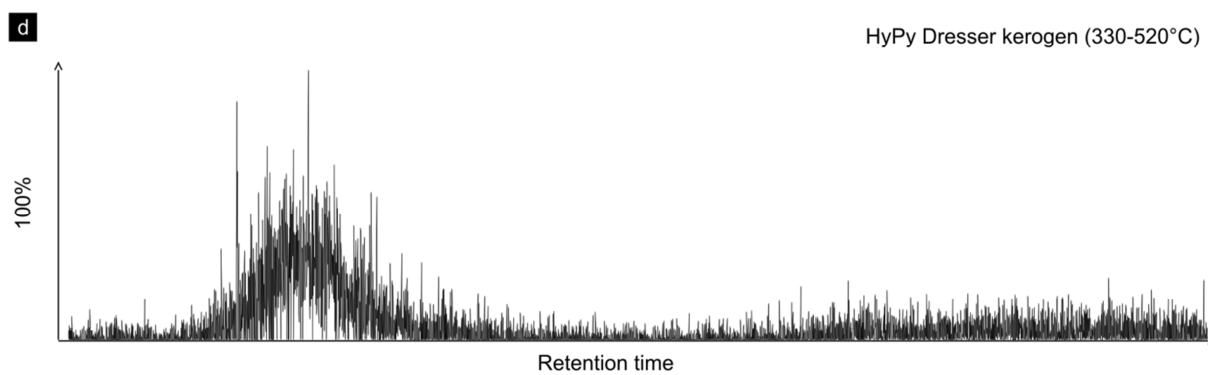
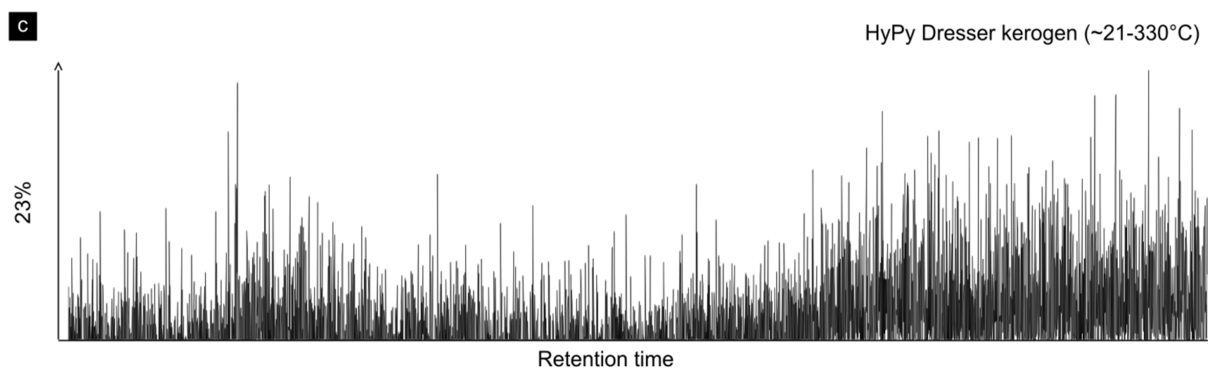
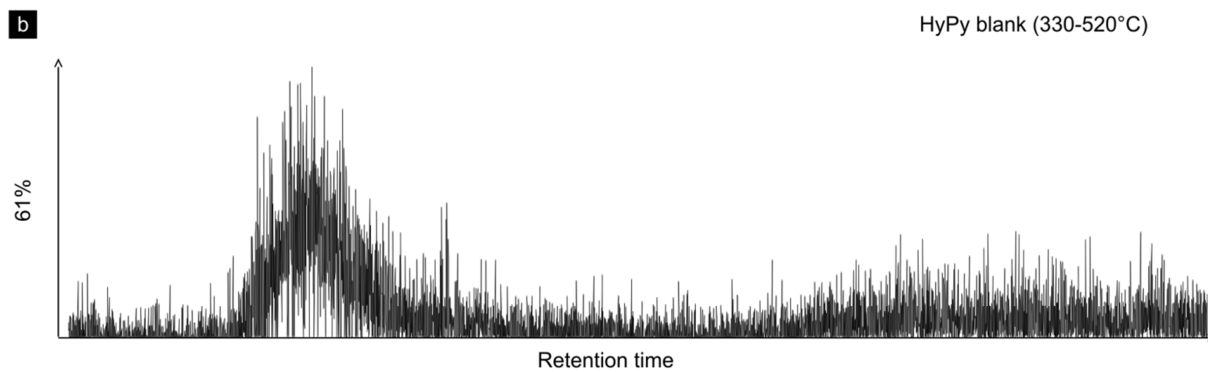
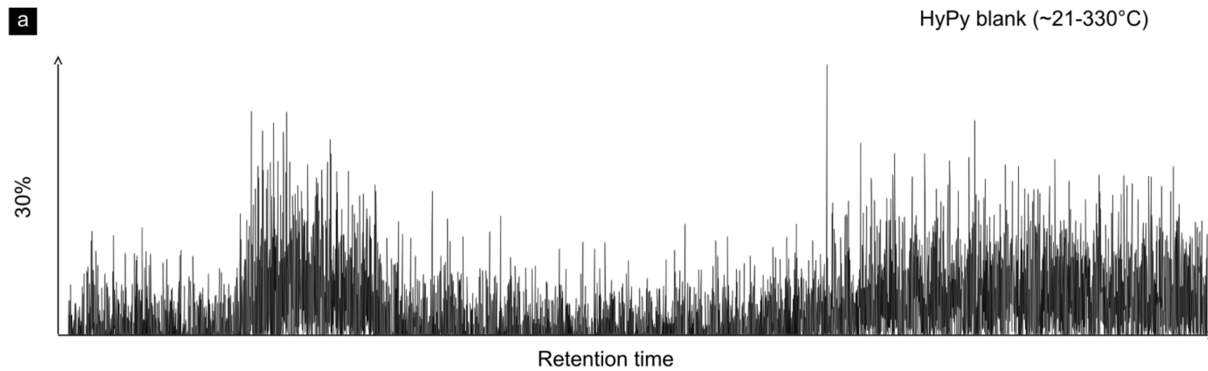


Fig. S9. Ion chromatograms selective for steranes (m/z 217). Low temperature (**a**) and high temperature (**b**) HyPy chromatograms of the analytical blank (combusted sea sand) obtained prior to HyPy of the Dresser kerogen. Low temperature (**c**) and high temperature (**d**) HyPy products of the Dresser kerogen. Note the absence of steranes in all chromatograms.

- 5 Note: Percentage values given on the vertical axes of chromatograms (**a–c**) relate peak intensities to chromatogram (**d**) (HyPy Dresser kerogen, 330–520°C).

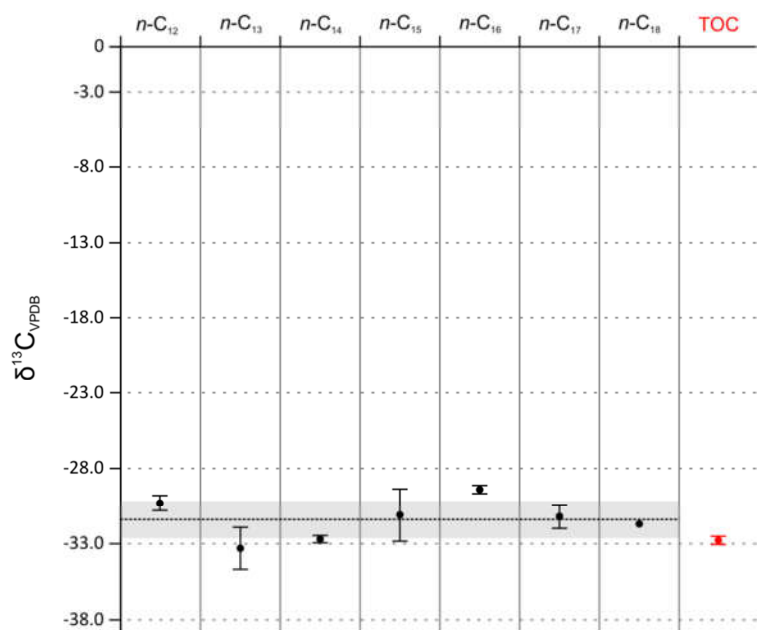


Fig. S10. Stable carbon isotope values ($\delta^{13}\text{C}$) of *n*-alkanes released upon high temperature HyPy and the total organic carbon (TOC). The isotopic similarity indicates that the *n*-alkanes (black dots) were generated from the kerogen (TOC, red dot).

5 Vertical lines: Standard deviations of $\delta^{13}\text{C}$ values; dotted horizontal line: mean $\delta^{13}\text{C}$ value of *n*-alkanes (-31.4 ‰); shaded area: standard deviation of mean $\delta^{13}\text{C}$ value of *n*-alkanes (± 1.2 ‰).