# Recovery and reproducibility of the conventional and accelerated solvent extraction methods for lipid biomarkers

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## Abstract

Biomarkers are widely used as tracers of the processes affecting organic matter cycling in the environment. Lipids, or more specifically hydrocarbons, sterols and fatty acids, are used extensively as indicators of the sources of organic matter as well as its alteration by photochemical or microbial degradation. The extraction of these lipids from sediments consists in a liquid-solid extraction using a mixture of non-polar solvents (most often dichloromethane and methanol). Conventional extraction of lipids from solid matrices traditionally involves ultrasonic extraction combined with shaking, or Soxhlet-based solvent refluxing. These two techniques are long and tedious and use low temperature and low pressure conditions to extract lipids. We recently found out that iron oxides associate very intimately with sedimentary organic matter, leading to the preservation of labile organic material, likely through covalent bonding [1]. Our results show that a fraction of the extractable lipids are not quantitatively recovered when using low temperature and low pressure methods for iron oxide-containing sediments. An extraction at high pressure and high temperature using an accelerated solvent extractor (ASE) disrupts these iron-organic matter structures, releasing the lipids into solution. The reproducibility and lipid recovery of the ultrasonication and ASE methods will be presented and discussed.

[1] Lalonde et al. (in press) *Nature*.

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# Sourcing hydrocarbons at two continental sites of present-day serpentinization: The Tablelands, NL, CAN and The Cedars, CA, USA

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The hydration of ultramafic rocks, via the serpentinization reaction, is a suspected source of putative hydrocarbons (methane and possibility higher molecular weight gases hydrocarbons) on Mars. On Earth, serpentinization produces hydrogen gas and the reducing conditions necessary for abiogenic hydrocarbon synthesis, while also producing conditions amenable for chemolithotrophic life. Additionally, on Earth, continental sites of serpentinization are often assoicated with buried sedimentary organic matter (SOM) that can possibly contribute thermogenic hydrocarbons to the ultra-basic reducing springs associated with the serpentinization. This study sources hydrocarbons from two continental sites (the Tablelands, NL, CAN and The Cedars, CA, USA) of present-day serpentinization where methane and higher molecular weight hydrocarbons are present in the ultra-basic reducing springs discharging from altered ultramafic rocks.

The Cedars was the first site to be described where ultramafic rocks are undergoing present-day serpentinization at shallow depth and low temperature. The Cedars is part of California's Coast Ranges and is a section of a peridotite body that was obducted as part of the Franciscan Subduction Complex (Late Cretaceous). Conversely, the much older Tablelands Ophiolite, NL is part of the Bay of Island Ophiolite. The Tablelands Ophiolite is composed of ultramafic rocks that were obducted onto the eastern edge of ancient North America (Ordovician). Elevated concentrations of $H_2$, $CH_4$ and higher molecular weight hydrocarbons have been detected in the ultra-basic reducing springs discharging from The Cedars and the Tablelands. Our geochemical investigations show that the methane at The Cedars is primarily microbial in origin (for example $C_1/C_{2+} = 6000$, $\delta^{13}C = -68.0$ ‰), while the methane sampled from the Tablelands is not (for example $C_1/C_{2+} = 5$, $\delta^{13}C = -26.3$ ‰). However, the source of the higher molecular weight hydrocarbons may differ from the source of methane (The Cedars average $\delta^{13}C_{C2-C6}$ ~-23.6 ‰ and the Tablelands $\delta^{13}C_{C2-C6}$ ~-30.7‰). Both The Cedars and the Tablelands could have thermogenic and/or abiogenic hydrocarbons contributing to the hydrocarbons detected in the springs. The purpose of this study is to source the higher molecular weight hydrocarbons through the analyses of the hydrocarbons in the ultra-basic reducing springs and the SOM associated with the Ophiolite.