

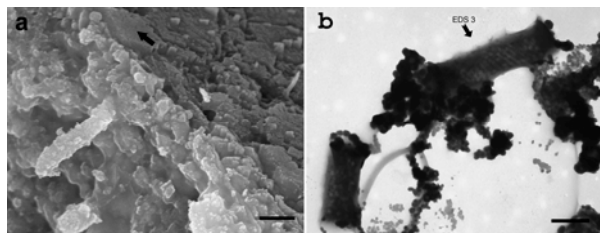
## Precipitation of low-temperature dolomite from an anaerobic microbial consortium: The role of methanogenic Archaea

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### Methanogenic Dolomite

Here we report precipitation of dolomite at low temperature (30°C) mediated by a mixed anaerobic microbial consortium composed of DIRB, fermenters, and methanogens. Initial solution geochemistry is controlled by DIRB, but after 90 days shifts to a system dominated by methanogens. Only after the onset of methanogenesis do we identify ordered dolomite in live microcosms, via powder x-ray diffraction, while sterile controls precipitate only calcite. SEM and TEM demonstrate that the precipitated dolomite is closely associated with cell walls and putative EPS (Fig 1).



**Figure 1:** SEM (a) and TEM (b) illustrating Mg-bearing carbonates associated with cell walls and EPS

### Discussion of Results

The absence of dolomite in sterilized controls and DGGE confirm that autotrophic and acetoclastic methanogens are necessary for ordered dolomite precipitation. Archaeal cell walls may serve as a template and to aid in overcoming the kinetic barriers for ordered dolomite formation at low Mg:Ca ratios. The dolomites precipitated in this study are small platy crystal aggregates (>0.5  $\mu\text{m}$  thick) closely associated with cell walls and EPS. This is different from other studies in which SRBs (absent from our microcosms) precipitate dolomites in distinct dumbbell and cauliflower-like morphologies [1,2]. These platy crystal aggregates may act to seed a system that may then undergo pervasive dolomitization.

[1] Warthmann *et al.* (2000) *Geology* **28**, 1091-1094. [2] Van Lith *et al.* (2003) *Geobiology* **1**, 71-79.

## Aerobic methane formation in plants

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Just three years ago, Keppler *et al.* [1] reported from laboratory experiments that living plants, plant litter and the structural plant component pectin emit  $\text{CH}_4$  to the atmosphere under aerobic conditions. These observations caused considerable controversy amongst the scientific community and the general public because of their far-reaching implications. This was mainly for two reasons. Firstly, it is generally accepted knowledge that the reduced compound  $\text{CH}_4$  can only be produced naturally from organic matter in the absence of oxygen, or at high temperatures, e.g. in biomass burning. The fact that no mechanism for an 'aerobic' production of  $\text{CH}_4$  had been previously identified at the molecular level in plants added to the consternation. Secondly, the first extrapolations from laboratory measurements to the global scale indicated that these emissions could constitute a substantial fraction of the total global emissions of  $\text{CH}_4$ .

After publication of Keppler's findings, their extrapolation procedure was severely criticised, and other up-scaling calculations suggested a lower, though still potentially significant plant source of  $\text{CH}_4$  emissions. At the same time, other independent observations indicated that vegetation might indeed still be a large source of  $\text{CH}_4$ . For example space, aircraft and surface observations suggested a strong  $\text{CH}_4$  source in tropical forest regions.

It became clear, that without further insight into the mechanism of the 'aerobic' production of  $\text{CH}_4$ , any up-scaling approach would have considerable uncertainties and thus be of questionable value.

Therefore, the principle scientific questions are now: if, by how much, and by what mechanisms is  $\text{CH}_4$  emitted from plant matter. In some subsequent studies (e.g. [2]) could not confirm the original findings of Keppler *et al.*. However, several more recent studies (e.g. [3]) have now confirmed Keppler's work. An overview of the current state of the art will be given in this presentation.

[1] Keppler, Hamilton, Brass & Rockmann (2006) *Nature* **439**, 187-191. [2] Dueck, *et al.* (2007). *New Phytologist* **175**, 29-35. [3] McLeod, *et al.* (2008). *New Phytologist* **180**, 124-132.