Novel records of past methane emission events from the Congo and Amazon fans

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The Congo and Amazon Fan are regions of important methane (CH_4) storage and gas seepage: gas hydrates abound at and just below the sediment surfaces as do large deeply-buried reservoirs of thermogenic methane linked with hydrocarbon source rocks. Although the steady methane seepage from the seafloor is well-documented in the present day, paleo-emissions from such regions remain unquantified due to the lack of an adequate tracer for reconstructing past methane emission and oxidation events.

Here, we present paleo-records spanning up to 200 ka and 1, 200 ka for the Amazon (ODP Site 942A) and Congo (ODP Site 1075A), respectively. We use the novel biomarker 35-aminobacteriohopane-30, 31, 32, 33, 34-pentol (aminopentol), specific to aerobic methane oxidising bacteria, and related bacteriohopanepolyols (BHPs) to estimate past intervals of intense methane oxidation in the water column over glacial/interglacial transitions to compare and contrast oxidation histories at these two sites situated on opposite sides of the Atlantic. These records are further compared to other reconstructed climatic parameters.

In the Congo core, methane oxidation intensity, and inferred emission, follows a distinct cyclical pattern that appears to correlate with marine oxygen isotope stages over the last ca. 1 Ma. The cyclicity of these events and compound-specific carbon isotope data suggest that hydrates are the principal methane source, suggesting that intervals characterised by high aminopentol concentrations reflect periods of increased hydrate destabilisation with greater methane emission occurring during interglacials. Investigation of the Amazon core also reveals dramatic variability in aminopentol concentrations, possibly also linked to orbital cyclicity and the destabilisation of hydrates, although ongoing investigation will allow the testing of this hypothesis and a direct comparison between the two sites. This work highlights the utility of aminopentol as a potential sedimentary tracer for past methane emission events from hydrates.

Birth of a giant Paleoproterozoic oil field: Re-Os ages for source rocks and maturation

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On the shores of Lake Onega in Russian Karelia, are exposures of extremely C-rich pyrobitumen – the fossil remains of a giant oil field [1]. In its purest form, this material approaches 100% C. In the Onega Basin, the pyrobitumen occurs in veins, lenses, and droplets within the Zaonezhskaya and Kondopozhskaya Formations, part of a Paleoproterozoic platform sequence developed on a rifted continental margin. C_{org}-rich siltstones are intercalated with basaltic flows and sills, including peperites. A Re-Os isochron for six samples of C_{org}-rich siltstone taken from a mine adit in Shunga village yields a precise age of 2.05 Ga [2], fitting existing constraints for the depositional age. The initial $^{187}Os/^{188}Os$ ratio (Os_i) given by the isochron for the Shunga adit samples is within uncertainty of chondritic (0.113 at 2.05 Ga), as expected in a restricted rift basin dominated by hydrothermal Os.

Re-Os data for samples from ICDP FAR-DEEP drillhole 13A near Shunga village, tell the rest of the story. Eleven ~500 mg samples, drilled from two 3-cm intervals 0.5 m apart in a single core, yield an isochron age of ~1.73 Ga with Os_i = 5. This age is consistent with a late phase of the Svecofennian orogeny [3], known to have impacted the Onega Basin.

Assuming isotopic homogenization (maturation) of the pyrobitumen took place during a relatively brief thermal maximum, the largest control on the present-day $^{187}Os/^{188}Os$ is the $^{187}Re/^{188}Os$. The $^{187}Re/^{188}Os$ for the 17 siltstone samples analyzed to date range from 280 to 1250. An average $^{187}Re/^{188}Os$ of 900 will raise the $^{187}Os/^{188}Os$ from 0.113 to about 5 during the 320 m. y. between deposition (2.05 Ga) and maturation (1.73 Ga) – precisely the value determined by our isochron. Similarly, the lower $^{187}Re/^{188}Os$ of 280 for three samples of lustrous pyrobitumen from the Shunga adit yields the measured $^{187}Os/^{188}Os$ of 10.2 for a maturation age of 1.73 Ga.

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[1] Melezhik *et al*. (2009) *Terra Nova* **21**: 119–126. [2] Hannah *et al*. (2008) *33rd IGC*, Oslo, **#1352701**. [3] Stein (2006) Lithos **87**: 300-327.