

## CHEMICAL FOSSILISATION: TESTING THE CONCEPT, WITH AMBERGRIS

S J Rowland<sup>1</sup>, P A Sutton<sup>1</sup>, A Baldanza<sup>2</sup> and G D Abbott<sup>3</sup>

<sup>1</sup> University of Plymouth, UK. <sup>2</sup>University of Perugia, Italy. <sup>3</sup> Newcastle University, UK.

### Introduction

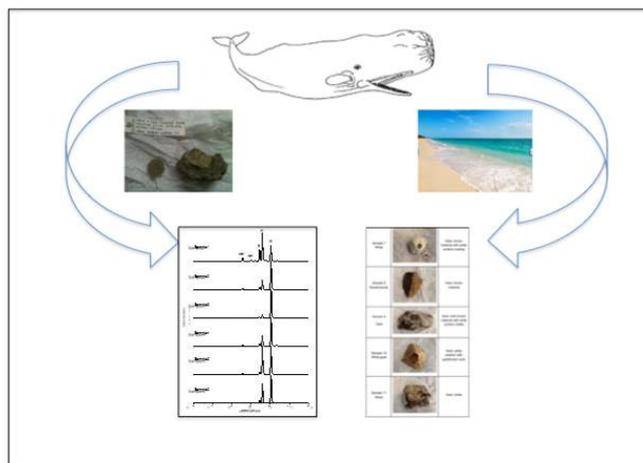
Opportunities to test the concept that a single organic chemical can be fossilised, are rare because most organic materials comprise complex mixtures of chemicals. The natural product of Sperm whales, ambergris, is however, a simple mixture of only one or two organic chemicals: i.e. ambrein and sometimes, epicoprostanol [Rowland and Sutton, 2017]. Fossilisation of ambergris is also rare but has been reported in the Pleistocene rocks of central Italy [Baldanza et al., 2013; Monaco et al., 2014]. Thus investigation of the latter for the predicted chemical fossils of ambrein and epicoprostanol (viz: ambrane and cholestane) might provide a unique opportunity to test the chemical fossil concept [Sutton and Rowland, 2016]. Here we describe analyses of modern and fossil ambergris.

### Results

Samples of modern ambergris were obtained from adventitious beaching of Sperm whales, from archived museum samples obtained when industrial whaling was practised and from jetsam samples beached in New Zealand. An analytical method was developed based on derivatisation of the hindered hydroxyl group of ambrein with Trisil reagents followed by gas chromatography-mass spectrometry (GC-MS) and high temperature GC-MS. Analyses showed that ambergris contained variable, but high, amounts of organic soluble material comprising almost pure ambrein to approximately 50/50 mixtures of ambrein and epicoprostanol. Mass spectra and GC retention indices of derivatised ambrein were obtained.

Ambrein was converted by hydrogenolysis to the predicted chemical fossil ambrane and mass spectra and GC retention indices of three isomeric ambranes obtained. Other putative diagenetic products of ambrein, including ambranol, ambrenes and aromatised analogues were also synthesised.

The synthetic compounds and purchased cholestane were used as reference materials to target a search for the relevant chemical fossils in organic extracts and insoluble 'kerogen' of multiple samples of fossil ambergris from the central Italy (Umbria Region) by GC-MS and pyrolysis-GC-MS. The results are reported.



**Figure 1** Schematic illustration of the fate of ambergris from Sperm whales. Fossilisation of ambergris provides a possibly unique opportunity to test the chemical fossil concept.

## References

- Baldanza, A., Bizzarri, R., Famiani, F., Monaco, P., Pellegrino, R., Sassi, P., 2013. Enigmatic, biogenically induced structures in Pleistocene marine deposits: a first record of fossil ambergris. *Geology* 41, 1075-1078.
- Monaco, P., Baldanza, A., Bizzarri, R., Famiani, F., Lezzerini, M., Sciuto, F., 2014. Ambergris cololites of Pleistocene sperm whales from central Italy and description of the new ichnogenus and ichnospecies *Ambergrisichnus alleronae*. *Palaeontologia Electronica* 17, 29A 20pp.
- Rowland, S. J. and Sutton P. A., 2017. Chromatographic and spectral studies of jetsam and archived ambergris. *Natural Product Research* (in revision).
- Sutton, P. A. and Rowland S, J., 2016. Spectral and chromatographic characterisation of the onocerooid, ambrane: a potential novel biological marker. *Organic Geochemistry* 102, 106–109.