P285-WE

USING LASER MICROPYROLYSIS TO DECIPHER THE CHEMICAL RECORD OF METAZOANS DURING THE "CAMBRIAN EXPLOSION"

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Representatives of nearly all the animal phyla living on Earth today made their first appearance in the fossil record near the base of the Cambrian (ca. 542 Ma). Considerable effort has been directed in recent years to elucidation of the apparently rapid radiation of metazoans during the "Cambrian Explosion" bioevent (e.g. Marshall, 2006). However, this research is challenged by the fact that conventional palaeontological studies are mostly limited to preserved hard parts of organisms and to trace fossils. Thus, relatively little information is available on the evolution of many soft-bodied organisms (~70% of typical metazoan biota), or the soft-parts of fossilised biota, due to the rapid decay of such tissues during the process of fossilisation. In contrast, some molecular residues of organisms survive the normal taphonomic processes of decay (e.g. Skinner, 2005) and can accumulate in host sediments. For example, it has been suggested that many of the soft bodied fossils from Early to Middle Cambrian Konservat-Lagerstätten deposits are preserved as organic (kerogenised) films resulting from interaction between clay minerals and the original lipids derived from the organisms (Butterfield, 1995).

As part of a wider palaeontological and organic geochemical study of the cryptic pre-history of major metazoan groups, laser micropyrolysis gas chromatography–mass spectrometry has been applied to an Early Cambrian shelly fossil. This technique allows 10-100 µm spot size analysis (Greenwood *et al.*, 1998), so spatially-selective chemical data can be acquired from different regions in a single fossil and the surrounding taphonomic residues. Initial experiments were carried out on chemically-isolated and hand-picked shells of the stem group brachiopod taxon *Askepasma* (Holmer *et al.*, 2006), from the Early Cambrian Wilkawillina Limestone, Flinders Ranges, South Australia. The calcium phosphate shells were ultrasonicated in dichloromethane prior to analysis. Organic-rich rocks such as the Sydney Basin torbanite laboratory standard pyrolyse at relative low powers (e.g. 10 x objective, 10A for 1 sec: 0.5 W). For *Askepasma*, laser power had to be increased (12.5A for 1 sec: 7.2 W), and multiple shots (5 to 10) were aggregated on the cold-trap. Under these conditions, laser micropyrolysis results were obtained that were significantly above the system blank for the instrument. Pyrolysis products include *n*-alkanes (Fig. 1), *n*-alkenes, alkylnaphthalenes, alkylphenanthrenes and other polycyclic aromatic hydrocarbons. Laser micropyrolysis on separate *Askepasma* shells gives reproducible data, with some variations, for example in the *n*-alkane molecular weight distribution. These initial data suggest that intracrystalline kerogenous material is preserved within the calcium phosphate matrix of the Cambrian shells, as has been documented for modern brachiopods (Curry *et al.*, 1991). Further experiments will aim to elucidate the kerogen composition and will investigate its origin, which could be from the original brachiopod, and/or from fungal or bacterial degradation products.

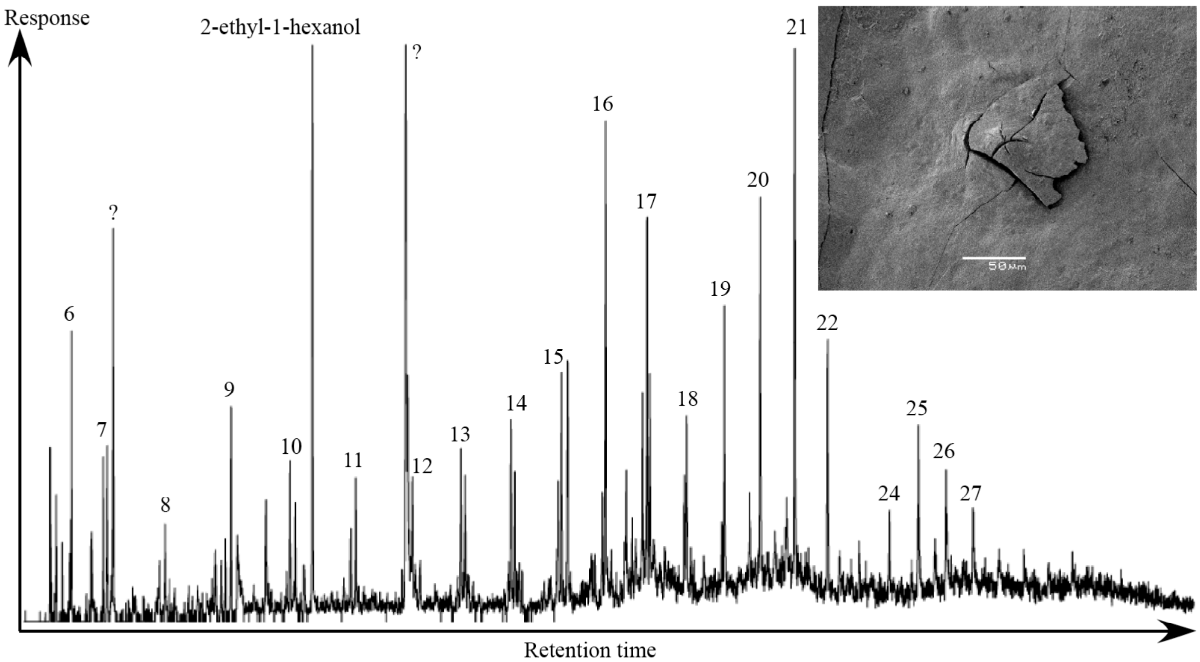

Figure 1. Mass chromatogram (*m/z* 57) of the laser micropyrolysis of an *Askepasma* shell (five laser shots aggregated), and SEM micrograph of one laser crater. Numbered peaks are *n*-alkanes.

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