Fine-scale analysis of permineralized fossil kerogen

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Recently, the biogenicity of some ancient permineralized microorganisms has been debated. However, *in situ* analyses of these and other such microfossils have shown their carbonaceous nature and provided three-dimensional morphological information by use of techniques applicable to any future extraterrestrial kerogenous objects that might be discovered.

In order to better understand the processes of organic maturation that occur during permineralization of ancient and (possible) extraterrestrial fossils, it is necessary to examine younger, terrestrial fossils. Primary among such processes is the alteration of organic cell walls to produce the kerogen that comprises such fossils, here studied by comparison of Eocene plant axes (cellularly permineralized specimens of a fossil fern from cherts of the Clarno and Allenby Formations, of Oregon and British Columbia, respectively). The composition and molecular structure of such samples were analyzed by ultraviolet Raman spectroscopy, ^{13}C-nuclear magnetic resonance spectroscopy, and pyrolysis-gas chromatography-mass spectrometry.

The fossil fern studied is cellularly well preserved in both geologic units. Specimens from the two units are similar in overall molecular structure being composed mostly of networks of aromatic rings and polyene chains and, unlike more mature kerogens, are not composed of large polycyclic aromatic hydrocarbons. Kerogen comprising the Allenby Fm. specimens, however, is geochemically less altered than that of the Clarno Fm., exhibiting more prevalent oxygen-containing functional groups and is present as a greater fraction of rock mass.