Raman and IR microspectroscopy of graphitic spheroids from 3.0Ga black chert,Cleaverville,Australia

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The microfossils regarded as records of the ancient life have been reported from Precambrian deposits. Almost all of them have been discovered as carbonaceous materials in sediments. However, biological origin of Archean microfossils are still under (Westall, 1999; Brasier et al., 2002). Spectroscopic analyses by using laser Raman and IR microspectroscopy have been conducted on black graphitic parts called microfossils, in order to find molecular traces of life.

Sample for this study is spheroidal carbonaceous objects in 3.0 Ga old black chert collected from the Cleaverville Formation, Western Australia (Ueno, 2002). Carbonaceous materials in the black chert are well preserved and have inner structure like cell wall or membrane, because of its low degree of metamorphism (prehnite-pumpellyite to lowermost greenschist facies; Ohta et al., 1996).

Micro-Raman spectroscopy showed that full width at half maximum (fwhm) of quartz in carbonaceous area tend to be larger than that of matrix quartz. Organic matter seems to induce low crystallinity of quartz. The ordered graphite peak (O-peak) around 1600 cm-1 of spheroidal carbonaceous material is shifted to higher wavenumber than that of form-less organics. The D/O ratio (disordered to ordered peak area ratio of graphite) of the spheroidal organics tends to be smaller than that of form-less ones, indicating more disordered structures of the spheroids.

IR micro-mapping results revealed that the distributions of peak heights at 3400 cm-1 (molecular water H2O) and 1300-1650 cm-1 (possibly C-N, N-H) are quite similar to those of carbonaceous materials. Almost all of the carbonaceous materials have disordered graphite peak (D-peak) which means structural deviations from well defined, three-dimensional sheet arrangement of graphite. Therefore, the carbonaceous materials may include polar molecules between graphitic layers.

These results suggest that the spheroidal carbonaceous material has traces of polar components (such as C-N, N-H) and forms a complex with silica and water. These spectroscopic characteristics of the ancient carbonaceous materials have potential to be used as criteria for biological origin of them.