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Focussed Ion Beam Preparation for the Nanoscopic Study of disintegrated Microfossils

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The ultra structure of acritarch cell walls from the c. 650 myr old Chichkan Formation was studied with optical microscopy (OM), Raman Spectroscopy, Scanning Electron Microscopy (SEM), Atomic Force Microscopy (AFM) and Transmission Electron Microscopy (TEM) in order to examine both mineralization and fossilization. The Unicells that appeared excellently preserved by light microscopy standards, in most cases of closer examination, consisted of disconnected kerogenous components that were dispersed in the cryptocrystalline quartz matrix and arranged in stacks of variable spacing. Cell structures preservation ranged from intact carbonaceous cell walls to walls with micrometer sized gaps, filled by quartz crystallites, between the carbon particles. Maceration was thus a preparation method that could not be applied. Thus partial etching of petrographic thin sections served as preparation method suitable for AFM and SEM studies. Focussed Ion Beam (FIB) selective preparation of the chert with sections normal to cell walls yielded stable thin foils of the same thin sections and microfossils. Also cells of low quality of preservation could thus be studied and compared to well preserved fossils. The integration of high resolution methods and classical optical microscopy, allowed to judge the relationship of the fossil to the embedding rock matrix and cements and to establish the authenticity of the fossil.

AFM images of cell cross sections are directly compared to high resolution electron microscopy at the same scale of magnification. AFM offers 3-D information on the arrangement of particulate carbon within the cell, SEM, TEM and Raman Spectroscopy yielding information on the crystallinity and chemical characteristics of the kerogen. The density of carbon particles was found to be correlative to the stability of cell walls and to in homogeneities in the chert. Whereas the microscopic appearance of cells was highly variable within the same rock unit, from the same locality in the Chichkan Formation, the nanoscopic structure of kerogen was found to be similar in all cells, consisting of multi- laminated (sheeted) amorphous carbon films, built up of layers with a measured thickness between 10nm and 20nm.