Pb-Pb age of earliest megascopic, eukaryotic algae bearing Vindhyan sediments, India

K.GOPALAN[1], S.SARANGI[1] AND S. KUMAR[2]

1. National Geophysical Research Institute, Hyderabad 500 007, India (postmast@csngri.ren.nic.in)
2. Geology Department, Lucknow University, Lucknow, India (surendra100@hotmail.com)

Considered to be the earliest known megascopic, photosynthetic eukaryotic algae, fossils of *Grypania spiralis* of similar size and morphology occur in India, China and USA but from sites of widely different ages – 1.0 Ga, India (Kumar, 1995); 1.4 Ga, China (Du and Tian, 1986); 1.8 Ga, Montana (Walter et al., 1976) and 2.1 Ga, Michigan (Han and Runnegar, 1992). As the only site representing the younger limit of such an extended *Grypania* biozone, the *Grypania* bearing Indian site must be directly and reliably dated.

We have therefore taken up Pb-Pb dating of carbonates from the *Grypania* bearing Rohtas Formation of the Lower Vindhyan Semri Group in the Son Valley (Kumar, 1995). Sixteen chips (~ 1 g each) from a small carbonate slab near Katni show a spread of $^{206}Pb/^{204}Pb$ ratios from 26.8 to 35.6 to yield a well defined Pb-Pb isochron (MSWD = 1.3) corresponding to an age of 1615±58 Ma (1σ). In good agreement with the inferred ages for the Rohtas Formation (Rasmussen et al., 2002; Ray et al., 2002), this result pushes the record of *Grypania spiralis* in India back by about 500 my and hence restricts its biozone to between 1500 and 2100 Ma.

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Regulation and assembly of extracellular polymeric substances by the facultative metal reducing bacterium *Shewanella oneidensis* strain MR-1

Y.A. GORBY, J. MCLEAN, G. PINCHUK, E. A. HILL, AND ALICE DOHNALKOVA

Pacific Northwest National Lab, Richland, WA (yuri.gorby@pnl.gov)

Production of extracellular polymeric substances by *Shewanella putrefaciens* strain MR-1 was examined under controlled conditions in continuous cultures using a chemically-defined medium with electron donor limitation. Cells produced EPS under aerobic conditions with dissolved oxygen concentrations ranging from 1 to 100 % of air saturation. Cells grown anaerobically with fumarate as the sole terminal electron acceptor did not produce visible assemblages of cells and no detectable EPS. Excess Ca^{2+} (provided as 0.7 mM $CaCl_2$) promoted the assembly of the EPS in aerobically grown cells while deficiency in Ca^{2+} inhibited the formation of the EPS matrix. The distribution of negatively charged sites on cell surfaces and within EPS matrix was examined by TEM using positively charged nanogold particles (1.4 nm diameter) as electron-dense contrasting agents. Cells that did not produce an EPS matrix (i.e., cultured anaerobically with high Ca^{2+} concentration and cells grown aerobically with low Ca^{2+} concentrations) exhibited a heterogeneous charge distribution similar to those described for S. algae strain CN32 (Sokolov et al., 2000). Cells that did produce an intact EPS matrix (i.e., cells cultured aerobically with sufficient amounts of Ca^{2+}) were poorly labelled with cationically-charged gold particles. However, all of the gold particles were bound by charged sites within the EPS matrix. Negatively charged sites (on cell surfaces and within the EPS) served as nucleation and growth sites for mixed Fe(II)/Fe(III) mineral phases when Fe(II) was added to anaerobic cell suspensions. These oxide phases were tentatively identified as a high-Fe(II)/Fe(III) ratio form of green rust. These results have important implications to the fate and transport of cations in aerobic/anaerobic transition zones in natural subsurface sediments and groundwaters and to the formation of highly redox-reactive minerals (green rusts) in iron reducing environments.

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