- extracting putative biosignals from spherical Iron oxide concretions from Utah that are thought to be analogous with the 'blueberry' structures seen on the surface of Mars
- the mapping of elements and the measurement of C/N ratios in ancient laminated sedimentary structures and modern stromatolites to investigate how geochemical signals degrade over time
- measuring sulphur isotope fractionation and elemental associations in micron-sized pyrite grains found within a 3.4 Ga sandstone from the early Pilbara.

All these examples illustrate the advantages gained by investigating geochemical signals, *in situ*, at the micron to sub-micron scale.

Are Archaean microfossils really biomorphs?

Andrew G Christy[1], Anna M Carnerup[2]
[1]Research School of Earth Sciences, Australian National University, [2]Department of Chemistry, University of Warwick, UK

'Biomorphs' are nanostructured inorganic composite materials that bear a morphological resemblance to primitive life forms. They self-assemble in very simple laboratory systems, whose chemistry bears strong resemblances to that of hydrothermal vent systems in the 3.5 billion year old Dresser Formation of the Pilbara. It is therefore possible that some early 'microfossils' are in fact biomorph pseudofossils. Distinguishing the two is not straightforward. The nanoscale structure is different, but is unlikely to be preserved in either biomorphs or microfossils. Organic matter content is not diagnostic of fossils, since biomorphs have been shown to secondarily adsorb hydrocarbons.

The shapes of biomorphs arise from the interplay between carbonate crystallites (or aggregates) elongated in a specific crystallographic direction, a coating of amorphous silicate which inhibits crystal growth, and a tendency for crystallites to form parallel or subparallel aggregates. A wide range of morphologies has been observed, and there are systematic changes in nucleation rate and morphology with variation of such parameters as temperature, pH and reactant concentrations, as we demonstrate. Observation of corresponding variation in nature could be diagnostic for recognition of biomorphs as opposed to true microfossils.

SESSION 01TD (TOPICAL: PALEOMAGNETISM)

New paleomagnetic study of the 1450 Ma Lakhna Dyke Swarm in the Bastar Craton, India: implications for the Mesoproterozoic supercontinent

Sergei Pisarevskiy[1], Tapaskumar Biswal[2], Bert De Waele[3], Jennifer Tait[1], Kamleshwar Ratre[2], Yengkhom Kesorjit Singh[2]
[1]School of GeoSciences, University of Edinburgh, [2]Department of Earth Sciences, Indian Institute of Technology Bombay, India, [3]SRK Consulting Perth

The Mesoproterozoic paleogeography has been widely debated during last decades. Most of recently published articles suggest the existence of a Mesoproterozoic supercontinent, variably called Columbia, Nuna, or Hudsonland. However, its exact configuration and history is still provisional, owing mainly to the small number of Neoproterozoic high-quality, well-dated paleomagnetic data available. Recent paleomagnetic and geochronological studies in Baltica, Siberia and Laurentia suggest that these three continents could have drifted jointly between 1500 and 1200 Ma. Consequently, they could represent the core of the Mesoproterozoic supercontinent. Unfortunately gaps in the paleomagnetic record in other continents (Australia, Amazonia, India, Congo, Kalahari etc.) prevent unequivocal Mesoproterozoic reconstructions. In particular, there are no reliable 1600–1200 Ma paleomagnetic data from India. This makes it impossible to reconstruct Indian paleopositions and even to find if India formed part of the Mesoproterozoic supercontinent at all. To fill this gap we studied the Lakhna dyke swarm in the Bastar craton. These dykes have been dated using zircon U-Pb SHRIMP method at 1450 ± 22, 1453 ± 19 and 1442 ± 30 Ma. Most of them are intruded along N-S, NNE-SSW trends with some along E-W direction. Dolerites have a N-S and WNW-ESE trend and are medium grained with plagioclase, olivine, and augite. We collected 128 oriented cores from 11 dykes. Thermal and AF demagnetisations were carried out in four laboratories in Utrecht, Lulea, Bergen and Edinburgh. Most dykes carry a stable coherent bipolar remanence. We used this new paleomagnetic pole and coeval poles from Baltica, Laurentia, Siberia together with paleomagnetic and geological data from Australia to find possible positions of India in the Mesoproterozoic supercontinent. Due to polarity ambiguity and longitudinal uncertainty the solution is not unique. However, the proximity of India to Australia is a possible scenario. Alternative reconstructions allow India to be close to Laurentia, but the possibility of an 'independent' drift of India cannot be excluded. This uncertainty could be reduced by more Mesoproterozoic paleomagnetic data from India. Here we present one version of an animated history of the Mesoproterozoic supercontinent with an emphasis on the possible role of India and Australia.

Palaeomagnetic evidence for cross-continental megashearing in Australia during late Neoproterozoic: no need for pre-750 Ma Rodinia breakup

Zheng-Xiang Li[1], David AD Evans[2]
[1]The Institute for Geoscience Research, Department of Applied Geology, Curtin University of Technology, [2]Department of Geology and Geophysics, Yale University, USA

The breakup of the Neoproterozoic supercontinent Rodinia may have triggered dramatic changes in the Earth's climate and atmospheric conditions, leading to the explosion of complex life. However, there is a longstanding controversy regarding the timing of the breakup events, particularly that between Australia-East Antarctica and Laurentia. Early palaeomagnetic work demanded the breakup of the SWEAT-type reconstructions, if valid, to have occurred by ca. 750 Ma (Wingate and Giddings, 2000). However, stratigraphic record in south-east Australia indicates a rift-drift transition between the Sturtian glacial deposits (*ca.* 750–690 Ma) and the overlying sag-phase deposits (Powell et al., 1994; Preiss, 2000) that were recently dated at ca. 650 Ma (Kendall et al., 2006). This geologically based age estimation from Australia agrees with those from South China where the rifting finished at around the time of the Nantuo glaciation (Wang and Li, 2003), dated at between ca. 650 Ma and 635 Ma (Condon et al., 2005; Hoffman and Li, 2009; Zhang et al., 2008; Zhou et al., 2004), and for western Laurentia (Ross, 1991; Fanning and Link, 2004). There are even younger rifting ages suggested for eastern Australia (Crawford et al., 1997).

There appear to be systematic and significant differences between pre-650 Ma palaeomagnetic pole positions from the North Australian Craton and those from the South-West Australian Craton (South Australian Craton plus West Australian Craton), making tectonic interpretations and Rodinia reconstructions equivocal (Li et al., 2008; Schmidt et al., 2006; Wingate et al., 2002). However, both these differences and the discrepancy on the timing of Rodinia breakup can be reconciled by a possible trans-continental mega-shearing along the Paterson and Musgrave Orogens, manifested as a ca. 30° clockwise rotation of the South+West Australian Cratons relative to the North Australian Craton around a vertical axis near the eastern Musgrave Block. The timing of the mega-shearing (the shear zone termed here the Paterson-Musgrave mega shear zone) was likely active between ca. 650 Ma and ca. 550 Ma, as evidenced by the ca. 650–550 Ma Ar-Ar muscovite ages and granitic intrusions in the Rudall Complex of central Paterson Orogen (Durocher et al., 2003) and the 600–550 Ma foreland basin deposition and metamorphic/cooling ages in and around the Musgrave Block (Aitken et al., 2009; Camacho, 2002). The late Neoproterozoic dextral sense of shearing at both the Rudall and Musgrave complexes (Aitken et al., 2009; Bagas, 2004) is consistent with the hypothesised sense of rotation.

By comparing the Proterozoic palaeopole positions between Australia (after correcting for the 30° rotation) with those of Laurentia, it is suggested that Rodinia probably did not break apart until ca. 650 Ma, thus agreeing with the stratigraphically estimated rift-drift transition time. The proposed 30° rotation probably occurred during Rodinia breakup. The revised Rodinia fit still has a large enough gap between Australia-East Antarctica and Laurentia that could accommodate continental blocks like South China.

References

Aitken ARA, Betts PG, Ailleres L 2009. Lithosphere 1, 343–357.

Bagas L 2004. Precambrian Res. 128, 475.

Camacho A, 2002. Geology 30, 887.

Condon D, Zhu MY, Bowring S, Wang W, Yang AH, Jin YG, 2005. Science 308, 95–98.

Crawford AJ, Stevens BPJ, Fanning M 1997. Aust. J. Earth Sci. 44, 831–852.

Durocher KE, Kyser TK, Marlatt J, Hanly A 2003. Aust. J. Earth Sci. 50, 601–610.

Hoffman PF, Li ZX 2009. Palaeogeog. Palaeoclimatol. Palaeoecol. 277, 158–172.

Kendall B, Creaser RA, Selby D 2006. Geology 34, 729–732.