Mineralogical Society Senior Bursary Report
Hugh Rollinson

35th International Geological Congress, Cape Town, 27th August-4th Sept 2016
Invited talk to the session 'Metamorphic processes in early Earth Evolution'

The session on Metamorphic processes in early Earth Evolution at the 35th IGC was convened by Eugene Grosch (Rhodes), Martin Whitehouse (Stockholm), Tim Johnson (Curtin) in order to explore the metamorphic record preserved in the Archaean and its implications for the geodynamic evolution of the early Earth. The overarching theme of the session was captured by Tim Johnson and Mike Brown in their talk 'Archaean metamorphism and geodynamics' in which they argued that the metamorphic record preserves secular change. They show that after 2.8 Ga there are two types of thermal gradient preserved in the metamorphic record – showing intermediate and high dT/dP. Prior to 2.8 Ga this paired metamorphism is not seen and only a high dT/dP is recorded. They propose that the Archaean metamorphic record displays evidence for a transition from geodynamic processes which are episodic and local, to those which are continuous and global and from a geodynamic regime dominated by mobile-lid tectonics to one dominated by global subduction.

Many of the talks reported newly determined metamorphic conditions in neo- to meso-Archaean terrains from southern Africa, Australia and the north China Craton. My own contribution was from the earliest metamorphic rock record at Isua in west Greenland where there are metamorphic rocks preserved from 3.7 and 3.8 Ga. Isua has become something of a battleground in the past decade with strongly polarised opinions suggesting that these rocks represent either a former ophiolite, or they were generated in a former arc. My talk entitled 'Thermal processes in the Eoarchaean: evidence from the 3.7-3.8 Ga Isua Greenstone Belt' focussed on both the volcanic and metamorphic records. Mafic volcanic rocks (basalt and picrite, but not komatiite) which dominate the succession have extremely variable geochemistry and have trace element signatures which range from enriched to strongly depleted, some of which represent the deep melting of refertilised depleted mantle. In part the mantle source is Th-enriched, but unlikely to have been fertilised with subducted sediment; mantle potential temperatures are in the range 1450-1575^{o}C. This complexity does not sit easily with any modern geodynamic environment. The metamorphic record is also complex with as many as three separate metamorphic events preserved. Pelitic rocks record pressures of up to 7 kb and temperatures of up to 650^{o}C with garnet growth at about 3.7 Ga. These conditions appear to conform to the high dT/dP metamorphism found elsewhere in the early Archaean. However, in detail, precise P-T conditions determined using modern approaches, have not yet been made, although one of the fruitful outcomes of this meeting is that we are now about to embark on this project.

Hugh Rollinson (left) with Eugene Grosch – session convenor.