What are the fundamental questions about how our planet works that we have not yet answered?

Tony Watts, University of Oxford

Early Earth (The first billion years)

- Did the impactor leave any record on the silicate Earth?
- When did surface water first appear and why was so little of it sequestered by Earth's mantle?
- When did plate tectonics begin?
- When did the Si-rich continental crust first appear?

Mantle dynamics

- How fast is Earth cooling?
- What is the spatial (e.g. whole vs. upper mantle) and temporal scale of convection?
- What is the volume flux of mantle plumes and their impact on the convection system?
- What role do convection (and plumes) play in explaining Earth's surface features (e.g. dynamic topography)?

Plate Mechanics

- How are the seismic, thermal and elastic thicknesses of the lithosphere related?
- What does reflectivity at the lithosphere/asthenosphere boundary mean?
- How close are tectonic stress levels to the failure envelope?
- How does the Wilson cycle work (e.g. ophiolite emplacement, cratonic basin formation)?

Subduction zones

- How do subduction zones initiate?
- What is the relative role of upper plate vs lower plate structure on the megathrust?
- What is the role of fluids (e.g. water) in the sub ducting plate?
- What is it about the mantle wedge that focuses arc volcanism above the sinking slab?

Rifts

- What is the role of structural heterogeneity in rift development?
- What controls the transition from half-grabens to rifts in continents and narrow vs. wide and amagmatic vs. magmatic rifts in rift margins?
- How does the crust thin in rifts?
- Why do some rift flank uplifts persist long after the end of rifting?

Surface Processes, Tectonics and Climate

- How does continental crust thicken in mountain belts?
- How do tectonics, erosion and climate shape landscapes AND what are their rates on geologic timescales?
- What is the impact of tectonic loading and climate driven erosional unloading on drainage systems?

Uniformitarianism, Scientific process and Convergence in the Geosciences

The present is the key to the past

The past is the key to the future

The past is the key to the future

Observation or Theory?

Field work (e.g. ships, drilling) or Modelling (e.g. parallel, supercomputer)?

Both!

Convergence

The integration of engineering, physical sciences, computation, and life sciences in order to bring about profound benefits for health, energy, and the environment.

e.g. natural disasters, Environmental health, Climate changes, Sustainability

Geoscientists have a role to play, but it should not be the only role!