Subduction Cycles and Deformation Questions (adapted from Draft Science Plan, April 2010)

1. What governs the size, location and frequency of great subduction zone earthquakes and how is this related to the spatial and temporal variation of slip behaviors observed along subduction faults?

- *What controls the magnitude and recurrence interval of earthquakes?*
- *What mechanical properties and/or fault zone conditions control the wide spectrum of slip rates observed on subduction megathrusts?*

2. How does deformation across the subduction plate boundary evolve in space and time, through the seismic cycle and beyond?

- *What is the time history of surface displacements throughout the seismic cycle, and what are the respective contributions from mantle flow, upper and lower plate deformation, and the plate boundary interface?*
- *What is the role of secondary faulting in the upper and lower plates in accommodating strain accumulation and what are the potential earthquake and tsunami hazards from earthquakes on these faults?*

3. How do volatile release and transfer affect the rheology and dynamics of the plate interface, from the incoming plate and trench through to the arc and backarc?

- *How does volatile release from the subducting sediments and igneous ocean crust affect the slip behavior of the subduction megathrust?*
- *What is the role of serpentinization in weakening the incoming plate and the plate interface?*
- *How does dehydration of the slab influence mantle wedge dynamics?*
- *What physical processes are associated with intermediate and deep earthquakes?*

4. How are volatiles, fluids, and melts stored, transferred, and released through the subduction system?

- *What is the role of serpentine in subduction and release of H2O?*
- *What is the relationship between dehydration reactions and the release of fluids and/or melts from the slab?*
- *What are the melting reactions and loci, and melt pathways from the mantle wedge to the surface?*
- *What are the fluxes of volatiles delivered to the mantle from the subducting slab and how are fluids and melts focused to the volcanic front?*
- *How do surface processes and climate modulate volatile inputs and outputs at subducting margins, and vice versa?*

5. What are the geochemical products of subduction zones, from mantle geochemical reservoirs to the architecture of arc lithosphere, and how do these influence the formation of new continental crust?

- *What are the geochemical characteristics of the materials that subduction returns to the Earth's mantle, and how are these related to the development of long-term mantle heterogeneity?*
- *What are the rates and processes of arc crust growth and differentiation and how is arc crust transformed to continental crust?*
- *What role do weathering and erosion play in the compositional and dynamic evolution of volcanoes and volcanic arcs?*

6. What are the physical and chemical conditions that control subduction zone initiation and the development of mature arc systems?

- *How does the initial tectonic state control the initiation and subsequent evolution of subduction, and how do plate kinematics, deformation, and petrology change before, during, and after initiation of subduction?*
- *How do the early products of island arc magmatism relate to the dynamics and conditions of subduction initiation?*
- *What controls the rate of subduction and the 3-D structure and geometry of a subduction zone over time, and how are these related to magmatism at the surface?*
- *What controls the distribution of volcanoes in space and time?*

7. What are the critical feedbacks between surface processes and subduction zone mechanics and dynamics?

- *How do erosion, sediment transfer, and deposition, interact with deformation and subduction geometry during plate boundary evolution?*
- *How do sediment dispersal patterns influence forearc evolution?*