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Mantle origins of landscape evolution : Mantle dynamics and kimberlite emplacement

Monday, 12 August 2013 11:00 (4 hours)

Mantle dynamics impact the behavior of Earth's surface, and vice versa. In particular, the buoyancy forces generated by density anomalies at depth can play an important role in land surface movements. Temperature and composition both influence the density of materials in the Earth's interior, with changes in these parameters often occurring during periods of geological activity leading to magmatism. On continents, underlying mantle activity is not always reflected in volcanism because the thick, cold continental lithosphere may act as a barrier, either trapping rising magmas or focusing them into particular locations by its internal structure. The lithosphere itself may undergo heating and chemical change (metasomatism) that influence its isostatic balance and elevation with respect to neighbouring regions. Thus, density changes and their surface impacts may be transient or long-lived, depending on their origins and where they are located within the underlying mantle. Although geophysical imaging and surface dynamics can provide some clues to mantle properties today, inferring what they were in the past, and how they changed with time relies on the evidence from mantle-derived rocks and tectonic reconstructions.
This section of the course will review the tectonomagmatic history of southern Africa from Gondwana times to the present and the basic geophysical structure of the underlying mantle. We will consider the relationship in space and time between surface volcanism and underlying mantle dynamics, and the impact of magmatic events on the thermal and chemical structure of the deep lithosphere of the African plate. A general introduction to the Karoo and Parana-Etendeka large igneous provinces, group I and group II kimberlites, and younger alkaline mafic rocks such as melilitites will be provided, and to the mantle xenoliths in kimberlites. We will examine evidence from mantle xenoliths for heating and metasomatism of the lithosphere, and the density implications. The goal is to provide a broad framework in which to assess the role of the mantle on surface movements, and to focus attention on some specific areas for future research.

Outline:
1. The present view of magmatism, topography, and deep Earth structure of Africa.
2. The structure of southern African lithosphere as a reflection of its tectonic history
3. Regional plate tectonic setting of S. Africa from ˜400 Ma and Gondwana breakup
4. Mesozoic magmatism: location, timing, petrology/geochemistry and origins
4.1 The Karoo LIP
4.2 Group II kimberlites
4.3 Group I kimberlites
4.4 Melilitites and other alkaline rocks.
4.5 The Parana-Etendeka LIP
4.6 The Agulhas Plateau
5. Mantle xenoliths and the evidence they contribute
5.1 Introduction to mantle xenoliths
5.2 Thermobarometry and mantle geotherms
5.3 The process of mantle metasomatism
5.4 A dynamic model for lithospheric evolution in southern Africa
6. Density changes in the mantle and possible surface consequences.

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Track Classification: Workshop Programme