AOGS-2006 Distinguished Lecture Series - Solid Earth Section

Formation and evolution of the continental crust

Bor-ming Jahn
Institute of Earth Sciences, Academia Sinica
PO Box 1-55, Nankang, Taipei, Taiwan 11529
(jahn@earth.sinica.edu.tw)

The Earth is distinguished from other terrestrial planets of the solar system by having a continental crust. The continental crust is geochemically evolved and contains a large volume of granitic rocks. The distinction is largely related to the presence of abundant water in the Earth but not in other planets. The continental crust covers about 40% of the Earth's surface. It is 30 to 80 km thick (average 40 km) and its base is defined by a prominent seismic velocity jump, the Mohorovicic discontinuity. The mean composition of the bulk continental crust has been established by various methods to be andesitic. The upper portion (top 15 km) of the continental crust is more felsic and has an average composition of granodiorite, whereas the lower part of the continental crust is poorly constrained. Uplifted crustal blocks, xenolith populations and seismic velocity data suggest that a large part of the lower continental crust is of mafic or basic composition. Geochemically, the continental crust contains an important global budget of incompatible trace elements, and geologically, it records the quasi-totality of the Earth's evolutionary history. Thus, study of the continental crust is very critical for our understanding of the evolution of the Earth.

Although the formation of the continental crust has long been studied, questions about the processes of its formation and evolution are still much debated. These questions include, for example, what was the nature of the first crust on Earth? When and how was the sialic crust produced? Did the continental mass grow episodically or continuously? Or has it not grown at all since the early Archean because of crustal recycling? What were the processes involved in the generation of juvenile crust and the destruction of the old crust? It is understood that the continental crust is ultimately derived by partial melting of the upper mantle. Geochemical studies also indicate that the continental crust is trace element enriched, and forms a complementary reservoir to the depleted mantle. However, experimental studies indicate that partial melting of mantle peridotites produces basic magma or mafic rocks, but not the kinds of rocks that constitute the continental crust. Consequently, additional processes are required to make the continent as it is now. In this lecture, the processes of continental growth and recycling will be emphasized. A specific example of crustal growth in the Central Asian Orogenic Belt will be presented.