Key component of Earth's crust formed from moving molten rock

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Layers of metamorphic rock, similar to granulite, in British Columbia. The coin is shown to provide scale. Credit: Gabriela Depine

Earth scientists are in the business of backing into history -- extrapolating what happened millions of years ago based on what they can observe now. Using this method, a team of Cornell researchers has created a mathematical computer model of the formation of granulite, a fine-grained metamorphic rock, in the Earth's crust.

By studying what were once pockets of hot, melted rock 13 kilometers (about 8 miles) deep in the Earth's crust 55 million years ago and calculating the period of cooling, the scientists were able to explain how granulite is formed as the molten rock migrates up through the crust.

The research is published in the March issue of the journal *Nature* by

Gabriela V. Depine, a fourth-year graduate student in earth and atmospheric sciences (EAS); Christopher L. Andronicos, an EAS associate professor; and Jason Phipps-Morgan, professor of EAS. The research is funded by Cornell and by the National Science Foundation's Continental Dynamics program.

Granulite, composed mainly of feldspars, has no residual water and is called metamorphic because it is formed in temperatures of greater than 800 degrees Celsius (1,472 degrees Fahrenheit). It is a major component of the continental crust.

Working in British Columbia in summer 2006, the researchers puzzled over the formation of granulite, which, unlike other rocks, forms under a wide range of depths but under a narrow range of temperatures. In many places on Earth, temperature is assumed to vary linearly with depth -- that is, the deeper the crust, the hotter the rock.

The researchers decided to mathematically recreate the formation of granulite at various depths, to see if they could come up a method that mirrors the natural formation of the rock.

They did so by looking at plutons, or pockets of hot, melted rock that were once as much as 13 kilometers below the Earth's surface but are now exposed. (Plutons that rise to the surface and erupt can become volcanoes.) The researchers found that as melted rock deep in the Earth becomes buoyant and migrates up through the crust, granulite can form at various depths but at similar temperatures.

Looking at the melting process is like looking at the process of the formation of continents, Andronicos explained.

"If you look over geologic time, not all the rocks are the same age, and the reason for that is they got formed at different times," he said. "So if

you can get a handle on the temperature, which is what controls melting and metamorphism, then you have a better idea of some of the fundamental controls that lead to rock formation, and therefore continents."

The computer model, he said, will hopefully provide further insight into the energy balance of the Earth during crustal formation.

Source: Cornell University

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