Flow in Earth's mantle moves mountains: study

June 2 2010

This wide angle view of the Earth is centered on the Atlantic Ocean between South America and Africa.

If tectonic plate collisions cause volcanic eruptions, as every fifth grader knows, why do some volcanoes erupt far from a plate boundary?

A study in *Nature* suggests that volcanoes and mountains in the Mediterranean can grow from the pressure of the semi-liquid mantle pushing on Earth's crust from below.

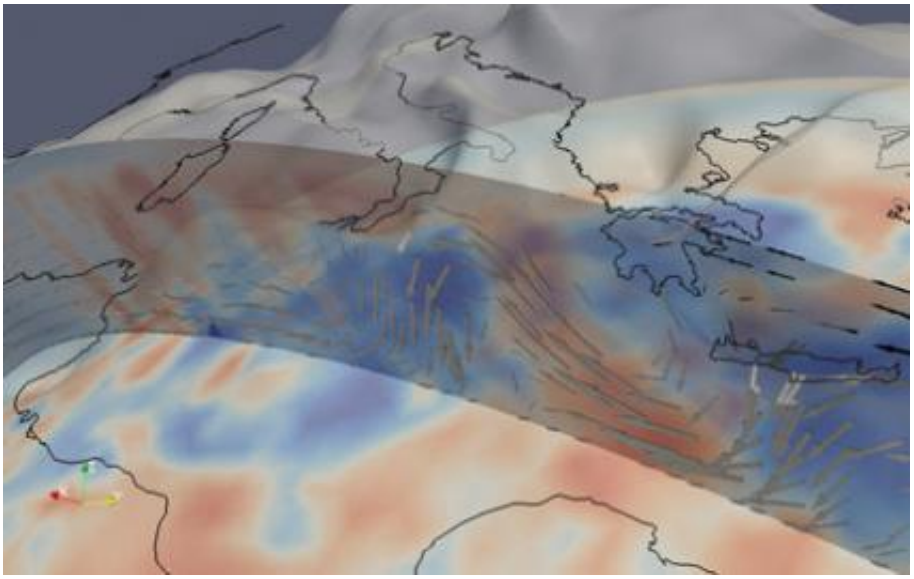
"The rise and subsidence of different points of the earth is not restricted to the exact locations of the plate boundary. You can get tectonic activity away from a plate boundary," said study co-author Thorsten Becker of the University of Southern California.

The study connects mantle flow to uplift and volcanism in "mobile belts": crustal fragments floating between continental plates.

The model should be able to predict uplift and likely volcanic hotspots in other mobile belts, such as the North American Cordillera (including the Rocky Mountains and Sierra Nevada) and the Himalayas.

"We have a tool to be able to answer these questions," Becker said.

Scientists previously had suggested a connection between mantle upwelling and volcanism, Becker said. The *Nature* study is the first to propose the connection in mobile belts.



Dynamic topography (gray surface) and mantle flow (vectors) as predicted by a geodynamic model for the Mediterranean.

Becker and collaborator Claudio Faccenna of the University of Rome believe that small-scale convection in the mantle is partly responsible for

shaping mobile belts.

Mantle that sinks at the plate boundary flows back up farther away, pushing on the crust and causing uplift and crustal motions detectable by global positioning system, the authors found.

The slow but inexorable motions can move mountains - both gradually and through earthquakes or eruptions.

The study identified two mountain ranges raised almost entirely by mantle flow, according to the authors: the southern Meseta Central plateau in Spain and the Massif Central in France.

Becker and Faccenna inferred mantle flow from interpreting seismic mantle tomography, which provides a picture of the deep earth just like a CAT scan, using seismic waves instead of X-rays.

Assuming that the speed of the waves depends mainly on the temperature of crust and mantle (waves travel slower through warmer matter), the authors used temperature differences to model the direction of mantle convection.

Regions of upward flow, as predicted by the model, mostly coincided with uplift or volcanic activity away from plate boundaries.

"Mantle circulation … appears more important than previously thought, and generates vigorous upwellings even far from the subduction zone," the authors wrote.

Provided by University of Southern California