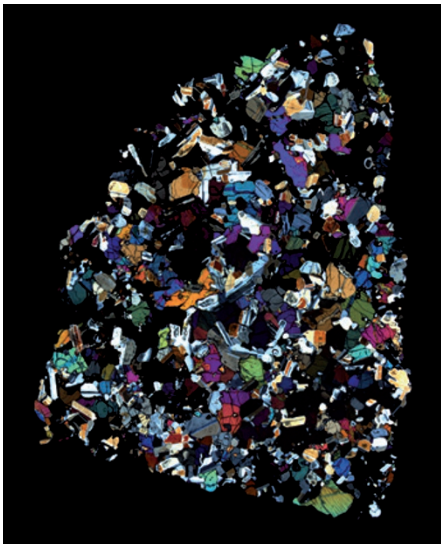
PLANETARY SCIENCE

Magmatic Vesta

Meteorit. Planet. Sci. http://doi.org/m68 (2013)



© NASA / JPL-CALTECH / HAP MCSWEEN, ANDREW BECK AND TIM MCCOY

A suite of meteorites found on Earth are widely considered to be samples of the upper and lower crust of the differentiated asteroid Vesta. A chemical model of Vesta's igneous history simulates an internal structure of the asteroid that is consistent with the diversity of meteorite compositions and spacecraft observations.

Ben Mandler at the Massachusetts Institute of Technology and Linda Elkins-Tanton at the Carnegie Institution for Science, Washington, DC, used the range of known compositions of meteorites from Vesta to model the chemical evolution of the asteroid as it solidified from an early molten state. The observed meteorite lithologies are best explained by a scenario in which an early magma ocean mostly crystallizes, and then the remaining melt crystallizes in shallower magma chambers. The model also predicts the composition of the deeper interior of the asteroid — the mantle — from which there are no confirmed meteorite samples.

The crustal thickness simulated by the model suggests that all of the known Vesta-borne meteorites could have been ejected during the formation of the Rheasilvia impact basin, without exposing the mantle — in agreement with remote observations of the Dawn spacecraft. *TG*

GEODYNAMICS

Mineral line-up

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Crystals in the uppermost mantle are often aligned, but it is unclear whether these preferred crystal orientations reflect current or ancient deformation processes. A comparison between global patterns of mantle-crystal alignment and present-day plate movements shows that most of the alignment is caused by geologically recent plate movements, with the fastest-moving plates creating the strongest patterns at their base.

Eric Debayle and Yanick Ricard at the Laboratoire de Géologie de Lyon, France, used seismic data to map global patterns of crystal alignment in the upper mantle and analyse large-scale deformation along the base of the tectonic plates. They compared the patterns to models of present-day and ancient plate motions, and found that the patterns of preferred crystal orientation predominantly correlate with the directions of plate tectonic movements today. Crystal alignment is most pronounced beneath the fastest-moving plates: the Indian, Cocos, Nazca, Australian, Philippine Sea and Pacific plates. In contrast, crystal alignment is rarely observed beneath the slowest plates.

The data imply that only the fastest-moving plates produce sufficient shear at their base to deform and align the mantle minerals. *AW*

OCEAN SCIENCE

Acidification and acclimation

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Continued acidification of the global ocean as a result of rising concentrations of atmospheric carbon dioxide reduces the formation of calcium carbonate in the oceans and could therefore impair the growth of carbonate coral skeletons. Corals that occur in naturally acidic waters near the Yucatan Peninsula show decreased levels of calcification, according to a morphological analysis of corals in the region.

Elizabeth Crook of the University of California, Santa Cruz, and colleagues used CT scanning to study the skeletal density and structure of *Porites astreoides,* a common species of Atlantic coral. The corals were collected from a region off the Caribbean coast in Mexico characterized by a natural gradient in pH. The annual rate of calcification — derived from measurements of coral density and structure — was up to 66% lower in areas with the lowest seawater calcium carbonate concentrations, relative to the nearby corals growing in more favourable conditions. The reduction in calcification matched that observed in laboratory experiments with the same coral species. The findings suggest that the studied corals are unable to acclimate to low calcium carbonate concentrations, despite lifelong exposure to such conditions.

The researchers also detected an increase in the degree of coral erosion and predation in the low-calcium-carbonate waters, which they suggest could further impair the reef ecosystem. *AA*

PALAEOCEANOGRAPHY

Miocene melt-down

Geology http://doi.org/m7b (2013)

About 23 million years ago, ice sheets on Antarctica temporarily expanded to near-modern volumes. An analysis of marine sediments suggests that this expansion was accompanied by cooling of deep waters and increased burial of organic carbon.

Elaine Mawbey and Caroline Lear of Cardiff University, Wales, measured the trace element composition of several species of bottom-dwelling foraminifera. Using these data, they calculated seawater temperature and carbonate ion availability, as well as trends in surface productivity and carbon burial in the deep equatorial Atlantic Ocean. They found that the period of Antarctic ice volume expansion from 23.24 to 23.04 million years ago was marked by two steps of cooling, and an increase in surface productivity and carbon burial. But the end of the cold event was perhaps more dramatic than its onset: two pulses of warming at the termination of the ice maximum were marked by the dissolution of carbonate in seafloor sediments.

The authors propose that the dissolution could have resulted from the gradual oxidation of the abundant organic carbon in the sediments following the warming of the bottom water, which would have released carbon to the oceans and atmosphere, promoting further warming and melting of the Antarctic ice sheet. *AN*

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