Calcium carbonate and climate change

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(PhysOrg.com) -- What links sea urchins, limestone and climate change? The common thread is calcium carbonate, one of the most widespread minerals on Earth. UC Davis researchers have now measured the energy changes among different forms of calcium carbonate, from its messy noncrystalline forms to beautiful calcite crystals that could lock away carbon underground for thousands to millions of years.

"Calcium carbonate is the major long-term sink for atmospheric carbon dioxide," said Alexandra Navrotsky, the Edward Roessler Chair in Mathematical and Physical Sciences and Distinguished Professor of Ceramic, Earth and Environmental Materials at UC Davis.

Steps to mitigate global climate change will likely include extracting carbon dioxide from power plant flues and the atmosphere and storing it underground, initially as a dense gas in old mines and depleted oil reservoirs that would eventually turn into solid, stable calcium carbonate through chemical reactions.

"By measuring the heat liberated during these transformations, we can study the process by which carbon dioxide is trapped and transformed to stable carbonate minerals," Navrotsky said.

Navrotsky is senior author on a paper describing the results, published this week in the journal Proceedings of the National Academy of Sciences.

Calcium carbonate exists in several forms with different levels of

stability. The first stage is noncrystalline, amorphous calcium carbonate. It forms when carbon dioxide mixes with calcium dissolved in water, either in the soil or in the oceans. Animals such as sea urchins and shellfish also make amorphous calcium carbonate and use it as a first step to build their spines and shells.

More stable forms have a repeating geometric crystal structure, culminating in calcite (Iceland spar), one of the most abundant minerals in the Earth's crust.

Navrotsky and her colleagues at UC Davis' Peter A. Rock Thermochemistry Laboratory have now measured with high accuracy the heat lost or gained as calcium carbonate changes from one form to another. They found that amorphous calcium carbonate made by chemical reactions is energetically similar to amorphous calcium carbonate extracted from a sea urchin, and that there is a series of downhill transformations ending in calcite as the most energetically stable version.

Provided by UC Davis