Study Suggests Clay Paved the Way for Evolution of Complex Animals

Strontium is one of the tools of research

Science News
February 03, 2006

Roughly 550 million years ago the first complex animals, such as trilobites, appear in the fossil record. Many scientists have concluded that an increase in the amount of atmospheric oxygen was critical to the relatively sudden evolution of these animals. They knew that photosynthetic organisms had been producing oxygen for hundreds of millions of years, but what might have led to the apparently rapid accumulation of the stuff in the atmosphere was a mystery. Now a team of researchers argues that clay may have played a key role.

Geologist Martin Kennedy and his colleagues from the University of California, Riverside realized that clay minerals in marine sediments are responsible for trapping the organic carbon that would otherwise bond with highly reactive oxygen. Today such clay minerals form in soil when organisms such as microbes or fungi interact with tiny bits of weathered rock. The resultant clay then washes down to the sea and settles on the bottom, where the clay's chemical properties actively attract organic carbon and then absorb it, much like kitty litter. The scientists reasoned that this so-called clay mineral factory might have produced the sharp rise in oxygen availability that preceded the flowering of complex life forms.

"We predicted we would only find a significant percentage of clay minerals in sediments toward the end of the Precambrian, when complex life arose, while earlier sediments would have less clay content," Kennedy explains. "Because clay minerals make up the bulk of sediment deposited today, we are saying that it should be largely absent in ancient rocks."

The scientists turned to one of the world's oldest outcroppings of ancient sedimentary rock, located in Australia. The oldest layers from around 850 million years ago are largely composed of silt, or rock bits that have undergone little chemical reaction. Around 600 million years ago, however, clay makes its appearance in this rock record. Outcroppings in China and Norway confirmed the rough chronology.

Other data sources also nearly match. For example, rock records of an isotope of strontium--87Sr--seem to show an increase in so-called chemical weathering, or weathering that is not simply the result of rain or other natural but not life-related processes. "Exactly when the terrestrial surface gets covered by some kind of organism, probably single cell, is not really well understood," Kennedy notes. "That's what our study is addressing."

In other words, microbes and possibly even fungi colonized the surface of the earth at this point in time, leading to the beginnings of a soil system that still functions today. One of the byproducts of that soil system was clay, which eroded down to the sea, trapped organic carbon and thus freed oxygen to percolate into the atmosphere. "The resulting six-fold increase in oxygen would have significantly influenced biogeochemical cycling of [oxidation] sensitive elements such as [iron] and [sulfur] and ultimately increased the oxygen concentration of the atmosphere," the team writes in a paper published online today by the journal Science. "The evolutionary innovation and expansion of land biota could permanently increase [chemical] weathering intensity and

[clay] formation, establishing a new level of organic carbon burial and oxygen accumulation." --David Biello