Nevada's Basin and Range: Down on its luck

The traditional story of the western United States reads like a geologic Horatio Alger tale. From a low birth, the landscape has pulled itself up by its bootstraps to reach its present high elevation. New studies, however, are deflating this story of the West's rising fortunes by showing that much of the landscape has actually lost elevation in the recent geologic past.

The latest blow to the textbook account comes from an analysis of fossil leaves in Nevada's Basin and Range geologic province, which separates the Sierra Nevada from the Rocky Mountains and the Colorado Plateau. The Basin and Range region consists of high ridges and flat, sediment-filled valleys, the bottoms of which now lie at 1,000 to 1,500 meters above sea level.

To probe the geologic history of this region, Jack A. Wolfe of the University of Arizona in Tucson and his colleagues studied fossil leaves at 12 sites in western Nevada. They analyzed each leaf for its shape, size, the number of notches around its margin, and other characteristics. Because moisture and temperature control these features, Wolfe and his colleagues could use the fossils to determine earlier climatic conditions of the Basin and Range. That climatic information was then fed into estimates of the landscape's previous altitude.

According to the new study, reported in the June 13 SCIENCE, the Basin and Range reached some 3,000 meters above sea level 16 million years ago, then dropped to its present height by about 13 million years ago.

Further back in time, the region apparently stood even taller, perhaps resembling the modern Andes, says Wolfe. Since then, the Nevada crust has stretched and thinned, causing the land to drop. "Presumably, in the long run, places like the Andes will show the same sort of pattern as the Basin and Range," he says.

Brian Wernicke of the California Institute of Technology in Pasadena and his colleagues reached a similar conclusion last year in a study of the Sierra Nevada. Most mountain ranges have a thick foundation of buoyant crustal rock, which makes them float high above the denser, underlying mantle. The scientists' seismic analysis showed that the Sierra crust is only 30 to 40 kilometers deep, not nearly thick enough to explain the range's current elevation. The group inferred that the Sierra and the Basin and Range once stood taller and had a thicker crust, which has thinned in the last 20 million years.

"This is a hard-core about-face," says Wernicke. "The idea had been that this was a low-elevation area, and it had been rising until now."

Howard E. Schorn/Univ. of California, Berkeley

Leading the high life: Fossil leaves from western Nevada indicate that the region's elevation 16 million years ago was nearly twice its current altitude.

His team is seeking to test its ideas by studying the canyons in the Sierra Nevada. If the range reached much higher in the past, it would have contained major canyons cutting into the heart of the mountains and helping to cool their molten interiors. Such accelerated cooling should have left a fingerprint in the existing rocks of the mountain range.

— R. Monastersky

Keys to an antibody's near-perfect fit

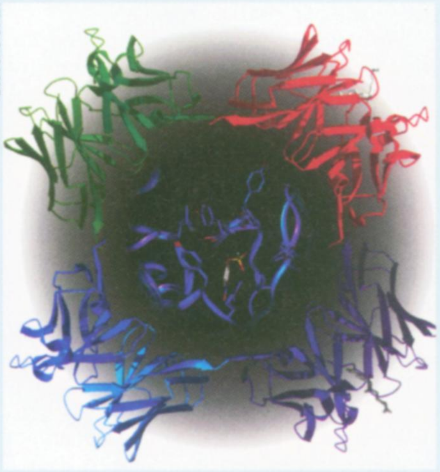
A lock that can be opened with many different keys wouldn't do a very good job of protecting a house. Yet a new study suggests that antibodies—the immune system proteins that tag foreign invaders—begin life as adaptable locks, changing shape to accommodate many different molecular keys. When the antibodies mature, they become like traditional locks, accepting just one key.

In the June 13 SCIENCE, researchers at the Lawrence Livermore (Calif.) National Laboratory provide evidence supporting this theory. They determined the three-dimensional structures of a mouse antibody that undergoes nine mutations between its immature and mature forms.

"It's a really elegant demonstration," says Sandra Smith-Gill of the National Cancer Institute in Bethesda, Md. "It gives a potential mechanism for [nonspecific] antibodies to become specific." With this strategy, the immune system may be able to recognize more foreign substances than scientists had previously thought.

Antibody maturation resembles evolution except that it occurs on a much more rapid time scale, says Smith-Gill.

Stevens et al.



An immature antibody (green) changes shape when it's bound to a foreign molecule (red). That altered shape becomes fixed in the mature antibody (blue), enabling it to bind to the molecule better than before (purple).

A foreign substance that binds to an antibody stimulates the production of more antibodies, many of which contain random mutations. Through a selection process, production of the tightest-binding antibodies flourishes, while cells making the other antibodies shut down.

The Livermore researchers measured the binding of the mouse antibody to hapten, a molecule that stimulates an immune response when attached to a protein. The mature antibody binds hapten 30,000 times better than its immature version.

Martin G. Weigert, a molecular biologist at Princeton University, disagrees with the researchers' interpretation of their findings. Weigert suspects that they have in fact determined the structures of two unrelated antibodies. In the currently accepted theory, each antibody binds to one kind of molecule from the start.

The Livermore researchers are studying other antibodies to determine how general their proposed mechanism is. Some newly produced antibodies might come close to matching their eventual targets and thus wouldn't need as many mutations as the mouse antibody did, says study coauthor Raymond C. Stevens. "Everything depends on how good the initial fit is."

An additional question, adds Smith-Gill, is whether mature antibodies can change shape. Studies in her laboratory suggest that they don't always lock out all but one key.

—C. Wu