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Study of Erosion and Precipitation in the Himalayas Presents Surprising Findings, Scholars Say

Scientists have found that, despite a vast difference in precipitation between the north and south sides of the Himalaya Mountains, rates of erosion are indistinguishable across these mountains.

Douglas Burbank, professor of geology and director of the Institute for Crustal Studies at the University of California, Santa Barbara, is the first author of the article, "Decoupling of erosion and precipitation in the Himalayas," to be published Thursday, December 11, in the international scientific journal *Nature*.

This four-year study of the interactions between climate, erosion and tectonic deformation was funded by the National Science Foundation. The Himalayas were chosen because of their unique combination of massive topography, monsoon rains, and rapid erosion.

The study relies on a network of 20 weather stations arrayed across the Himalayas. Jaakko Putkonen of the University of Washington installed and maintains the weather stations. These stations are unique in that many of them are located on mountain tops as high as 15,000 feet, whereas nearly all weather stations around the world are located in valleys.

Burbank and his team found that the difference in precipitation between the north and south is striking. The monsoon rains that originate over the Indian Ocean are drawn toward the Himalayas. As monsoon storms rise over the mountains, their moisture is wrung out of them, drenching the south side of the Himalayas with 15 feet of rainfall each summer. By contrast, to the north of the Himalayan summits, summer rainfall amounts to only about one foot. "Given this profound difference in rainfall, we expected to see large differences in rates of erosion. But this is not what we found," said Burbank.

Additionally, he explained that the tectonic plate of India is colliding with and thrusting under that of Asia at a rate of about two inches per year. About half of that collision is absorbed by the Himalayas, thrusting the mountains upward between India and Tibet. When coupled with erosion, this thrusting carries rocks to the surface from deep in the Earth's c

As rocks move toward the surface, they cool, and this cooling provides the researchers with a means to measure erosion at geological time scales of millions of years.

Using a mineral-dating technique called fission-track dating, co-author Ann Blythe at the University of Southern California showed that it took about a half a million years for Himalayan rocks to cool from about 280 degrees Fahrenheit to surface temperatures. Because temperatures of 280 degrees occur one to two miles deep in the crust, Blythe's dating implies that two to four miles of rock are eroded from the Himalaya every million years.

Not only are these rates of erosion rapid, but they show no significant variation from the monsoon-drenched flank of the Himalaya to the arid conditions north of the range. This unexpected discovery led the researchers to search for the cause of this uniform erosion.

They noted that, as the climate gets drier, the mountainsides get steeper. Such steep slopes can cause landslides (and erosion) more easily with less rainfall than a gentle slope. Also, glaciers periodically advance across the northern areas and may erode very efficiently, despite the drier climate. Burbank and his team also proposed that river channels get narrower in the drier areas, thus concentrating more energy on the bedrock and eroding it just as fast as in the wetter areas.

The importance of this study, he said, lies in the fact that erosion rates are not closely linked to the dramatic changes in climate. Instead, the collision of India and Asia drives rocks steadily upward in the Himalaya and erosion sweeps them rapidly away.

In this project, Burbank is spearheading work by scholars at six other universities besides UCSB: Harvard, Dartmouth, MIT, University of Southern California, University of Washington, and the University of Wyoming. They work with the Nepalese Department of Hydrology and Meteorology.

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