TECTONICS

Pumping Up the Tibetan Plateau From the Far Pacific Ocean

Explaining how an area the size of Alaska got to be higher on average than the highest peak in the contiguous United States doesn't seem all that difficult: Just blame India. The roving subcontinent plowed into Eurasia beginning 50 million years ago and hasn't stopped yet. When it comes to working out the details, however, the Tibetan question remains the most contentious in tectonics. "There's a lot of gabbing, and we're not much further along than we were 20 years ago," says geochemist T. Mark Harrison of the University of California, Los Angeles (UCLA).

The problem is that researchers can't see much of what's going on beneath the plateau. Is the underlying rock strong and rigid or flowing like molasses? On page 1054, geoscientists Leigh Royden, B. Clark Burchfiel, and Robert van der Hilst of the Massachusetts Institute of Technology (MIT) in Cambridge argue that rock has flowed west to east beneath the plateau to inflate its eastern side and that the flow has been throttled by tectonic doings as far as thousands of kilometers away.

There is some agreement about how the Tibetan Plateau story begins, at least. In the western portion of the collision zone—where India smashed into the rigid and resisting block of the Tarim Basin—the colliding continents squeezed the intervening rock into the great Karakoram Range. To the east, with hot, weak rock and no rigid backstop in the way to strengthen the continents' grip, the collision sent great chunks of rock eastward. Piled 5 kilometers high to the west, crustal rock weighed heavily on the rock beneath, driving fragments toward southeast China and Indonesia without raising much of a plateau in the east.

This eastward extrusion, the MIT group is now pointing out, coincided with stirrings of the plates of the western Pacific. There, ocean plates were diving into deep-sea trenches and heading under Asia. The trenches, meanwhile, were rapidly retreating from the continent. This trench retreat made room for the crustal rock being extruded eastward and southward from Tibet, the MIT group reasons. When the trench retreat ground to a halt between 30 million and 20 million years ago, the researchers argue, the extruded material began to pile up, thickening the crust faster than before and thus pumping up the plateau.

Another, much more local gating of flow explains why the central plateau thrust upward about 10 million years ago, the group suggests. Normally, such a rise would leave deformed rock and other signs that the crust had been compressed and squeezed. No such compressional markings have been found in the east. Instead, north-south faults in the eastern plateau show that the crust was actually stretching east and west. To explain the paradox, the MIT group posits that a "dam" of strong, rigid rock beneath the plateau busted about 15 million years ago. Deep, weak crustal rock gushed eastward, stretching the central plateau by its departure and pushing up the eastern plateau. Traces of that rock monsoon may have turned up in seismic images of an apparently weak crustal layer deep beneath the eastern plateau, which van der Hilst and colleagues published earlier this year in *Geophysical Journal International*.

Not everyone agrees that crustal flow was crucial. In the May issue of *Geology*, seismologist Paul Silver of the Carnegie Institution of Washington's Department of Terrestrial Magnetism in Washington, D.C., and

GENOMICS

'Simple' Animal's Genome Proves Unexpectedly Complex

Aptly named "sticky hairy plate," *Trichoplax adhaerens* barely qualifies as an animal. About 1 millimeter long and covered with cilia, this flat marine organism lacks a stomach, muscles, nerves, and gonads, even a head. It glides along like an amoeba, its lower layer of cells releasing enzymes that digest algae beneath its ever-changing body, and it reproduces by splitting or budding off progeny. Yet this animal's genome looks surprisingly like ours, says Daniel Rokhsar, an evolutionary biologist at the University of California, Berkeley (UCB) and the U.S. Department of Energy Joint Genome Institute in Walnut Creek, California. Its 98 million DNA base pairs include many of the genes responsible for guiding the development of other animals' complex shapes and organs, he and his colleagues report in the 21 August issue of *Nature*.

Simple—or simplified? It's a puzzle why *Trichoplax*, a seemingly primitive animal, has such a complex genome.

Biologists had once assumed that complicated body plans and complex genomes went hand in hand. But *T. adhaerens*'s genome, following on the heels of the discovery of a similarly sophisticated genome in a sea anemone (*Science*, 6 July 2007, p. 86), "highlights a disconnect between molecular and morphological complexity," says Mark Martindale, an experimental embryologist at the University of Hawaii, Honolulu. Adds Casey Dunn, an evolutionary biologist at Brown University, "It is now completely clear that genomic complexity was present very early on" in animal evolution.

Ever since German zoologist Franz Eilhard Schulze first found *Trichoplax* more than a century ago in a saltwater aquarium, this disc-shaped animal has stirred debate. It has just four apparent types of cells, prompting Schulze and others to consider it a holdover from the earliest animals. They eventually assigned it to its own phylum, Placozoa.

But not everyone agrees which branch of the animal tree of life is oldest: sponges, comb jellies, or placozoans. And a few researchers have dismissively argued that placozoans are just larvae of cnidarians—jellyfish, sea anemones, and the like—or else a streamlined version of a cnidarian ancestor.

Rokhsar, his graduate student Mansi Srivastava, and their colleagues sequenced a *Trichoplax* from the Red Sea, finding an estimated 11,514 protein-coding genes.

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Informative disaster. The Sichuan quake holds clues to what has driven the rise of the Tibetan Plateau.

colleagues presented seismic probings of the "fabric" of the crust and deeper mantle rock of the plateau. The strong similarity of crustal and mantle fabrics "disallows the lower crustal flow model" of the MIT group, Silver says, because such flow would have disconnected the crust from the mantle, leading to different fabrics. As to the apparent absence of signs of squeezing in the eastern plateau, the heavily forested eastern area "is a good place for panda bears but a bad place for geologists to make geologic maps," writes geoscientist An Yin of UCLA in an e-mail.

May's devastating earthquake in the Sichuan region of China on the eastern edge of the plateau might eventually help resolve the Tibetan question. Burchfiel, Royden, van der Hilst, and colleagues argue in the July issue of *GSA Today* that the quake mainly reflects slow uplift, consistent with crustal flow. But so far, others see dramatic evidence of severe squeezing and crustal deformation. And how the deeper crust and mantle slowly recover from the shock of the quake could reveal just how weak and prone to flow the deeper rock of the plateau actually is. **–RICHARD A. KERR**

After comparing the sequences of 104 *Trichoplax* genes with their counterparts in other organisms, they concluded that placozoans aren't the oldest animals; they branched off after sponges but before cnidaria. Placing *Trichoplax* on the tree "will now allow us to understand how to interpret its biology in the context of animals as a whole," says Dunn.

The sequence is also clarifying what ancient genomes looked like. *Trichoplax* genes have comparable numbers of introns, noncoding regions interspersed between the coding regions, as vertebrates and as the sea anemone. And many of the same genes were linked on the chromosomes of vertebrates, *Trichoplax*, and sea anemones, the researchers report. This was not the case with the fruit fly and nematode genomes, whose genes have fewer introns and have moved about quite a bit.

Despite being developmentally simple—with no organs or many specialized cells—the placozoan has counterparts of the transcription factors that more complex organisms need to make their many body parts and tissues. It also has genes for many of the proteins, such as membrane proteins, needed for specialized cells to coordinate their function. "Many genes viewed as having particular 'functions' in bilaterians or mammals turn out to have much deeper evolutionary history than expected, raising questions about why they evolved," says Douglas Erwin, an evolutionary biologist at the Smithsonian National Museum of Natural History (NMNH) in Washington, D.C.

Trichoplax could yet be more complex than observed, perhaps having subtle differences in cell types. Or, the amoeboid form may be just one phase of a complex life cycle that's still undiscovered, says Rokhsar.

The surprises in the *Trichoplax* genome emphasize the importance of sequencing other early-arising species, such as comb jellies or different kinds of sponges, says evolutionary biologist Allen Collins of the National Marine Fisheries Service and NMNH. "The more taxa we fill in," says Collins, "the clearer our picture will be for how the entire suite of these molecules evolved over the critical time early in metazoan history." **–ELIZABETH PENNISI**

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SCIENCE**SCOPE**

Obama: Lunar Sooner

Both major U.S. presidential candidates looked to the heavens last week. Senator Barack Obama (D–IL) supported President George W. Bush's plan to return humans to the moon as part of a seven-page space policy white paper that also calls for increasing international efforts in space. Senator John McCain (R–AZ), during an event near NASA's Kennedy Space Center in Cape Canaveral, Florida, backed current efforts to build a successor to the shuttle to transport humans and material but did not support returning to the moon. Both men are keen to win support in the battleground state of Florida. **–ANDREW LAWLER**

Plans for Nuclear Plant Proposed

Last week, the U.S. Nuclear Regulatory Commission told Congress how it plans to license a nuclear reactor that would use technologies not yet invented or tested to produce electricity, heat, and hydrogen. The Department of Energy's (DOE's) $2.4 billion Next Generation Nuclear Plant, to be built at Idaho National Laboratory, is supposed to demonstrate the feasibility of a gas-cooled reactor that operates at 950°C, three times the temperature of current water-cooled reactors. Congress has ordered DOE to complete the plant by 2021, and last week regulators explained how it hopes to conduct research to license the plant by 2017. But that timetable is too ambitious, warns Edward Lyman of the Union of Concerned Scientists, noting that reactor materials able to withstand such high temperatures don't exist. **–ELI KINTISCH**

Vioxx Trial Criticized

Researchers combing through internal memos and other correspondence submitted by the drug company Merck in suits involving its anti-inflammatory drug Vioxx claim that a clinical trial carried out in 1999 was actually initiated by Merck's marketing department to promote sales. The trial, which compared the gastrointestinal effects of Vioxx and naproxen, a commonly used anti-inflammatory, was largely run by primary care doctors. In contrast, most clinical trials are run by specialists, suggesting that the company wanted to create buzz for the drug with the doctors likely to prescribe it. The authors of the criticism, published this week in the *Annals of Internal Medicine*, were all paid consultants to attorneys representing plaintiffs that sued Merck for heart attacks they say were caused by the drug. The company says the study, published in the *Annals* in 2003, was not done for marketing purposes.
–JENNIFER COUZIN