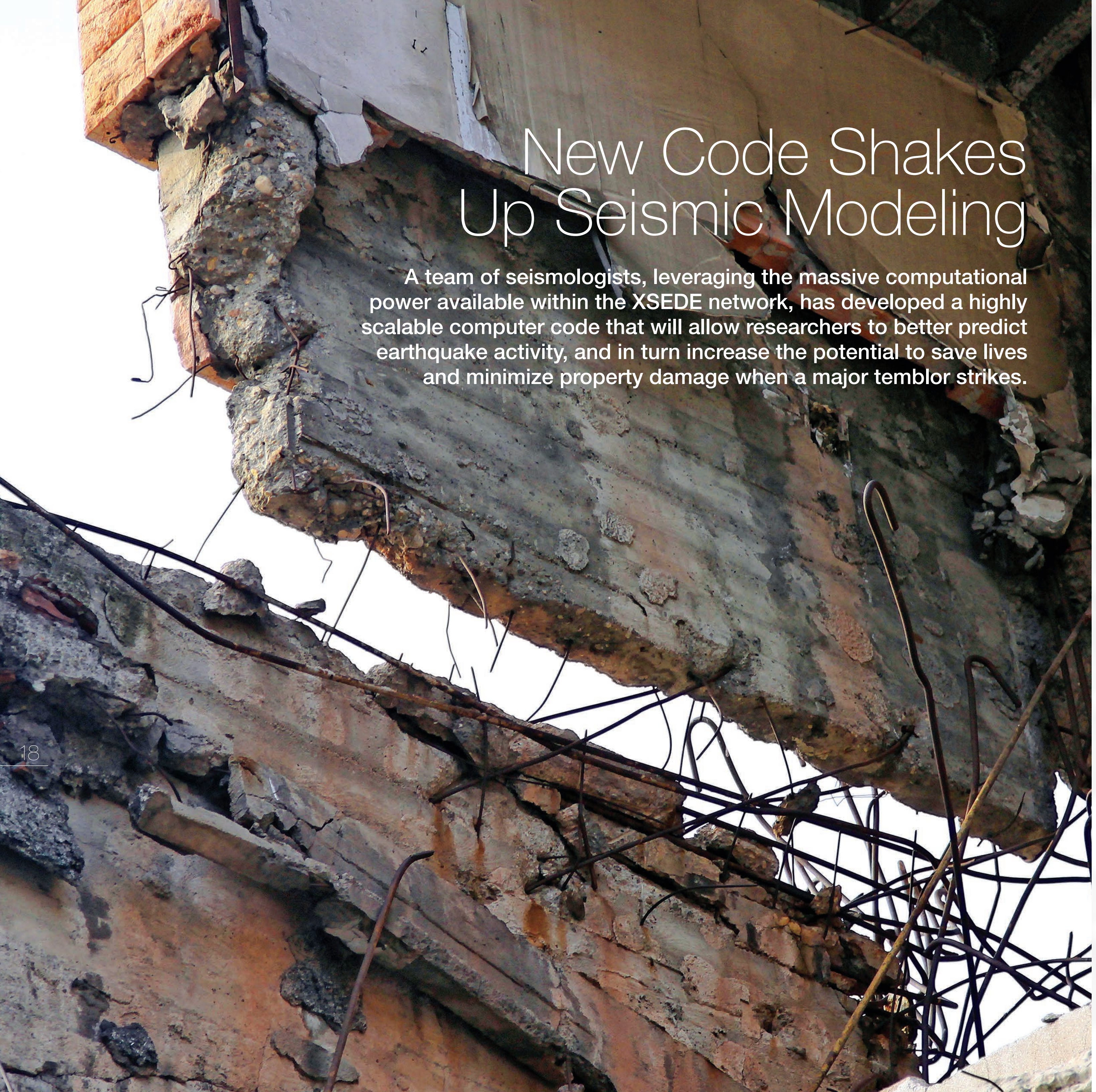


New Code Shakes Up Seismic Modeling

A team of seismologists, leveraging the massive computational power available within the XSEDE network, has developed a highly scalable computer code that will allow researchers to better predict earthquake activity, and in turn increase the potential to save lives and minimize property damage when a major temblor strikes.

The breakthrough—using accelerated GPU code in place of CPUs to allow a sustained two petaflop/s performance—also means a dramatic reduction in both research time and energy costs in simulating seismic hazards.

The team, led by Yifeng Cui, a computational scientist at the San Diego Supercomputer Center (SDSC) at the University of California, San Diego, developed the accelerated code for use in earthquake engineering and disaster management through regional earthquake simulations at the petascale level as part of a larger computational effort coordinated by the Southern California Earthquake Center (SCEC).

"The increased capability of GPUs, combined with the high-level GPU programming language CUDA, gives us the tremendous power required for acceleration of numerically intensive 3D simulation of earthquake ground motions," according to Cui.

The accelerated code is based on a widely-used wave propagation code called AWP-ODC, which stands for Anelastic Wave Propagation by Olsen, Day and Cui. It was named after Kim Olsen and Steven Day, geological science professors at San Diego State University, and SDSC's Cui. The research team restructured the code to exploit high performance and throughput, memory locality, and overlapping of computation and communication, which made it possible to scale the code linearly to more than 8,000 NVIDIA Kepler GPU accelerators.

Using the Keeneland system managed by Georgia Tech, Oak Ridge National Laboratory (ORNL), and the National Institute for Computational Sciences (NICS), the team performed GPU-based benchmark simulations of the 5.4 magnitude earthquake that occurred in July 2008 below Chino Hills, near Los Angeles. Researchers were able to achieve a five-fold speedup over a heavily optimized CPU code and a sustained performance of two petaflops per second (or two quadrillion calculations per second). A previous seismic simulation milestone performance peaked in 2010 at only 200 teraflops (trillions of calculations per second) sustained.

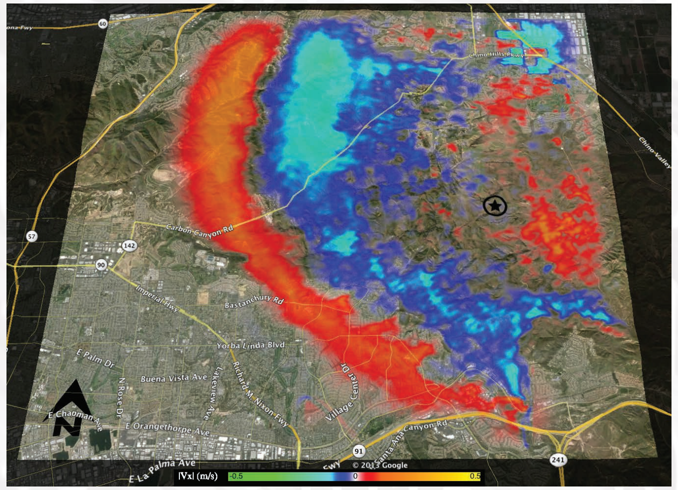
"This is an impressive achievement that has made petascale-level computing a reality for us, opening up some new and really interesting possibilities for earthquake research," said Thomas Jordan, SCEC's director.

NEXT STEPS

While the GPU-based AWP-ODC code is already in research use, further enhancements are being planned. "One goal going forward is to use this code to calculate an improved probabilistic seismic hazard forecast for the earthquake-prone California region," said Cui. "Our ultimate goal is to support development of a CyberShake model that can assimilate information during earthquake cascades so we can improve our operational forecasting and early warning systems."

CyberShake is a SCEC project focused on developing new approaches to performing seismic hazard analyses using 3D waveform modeling. The GPU-based code has potential to save hundreds of millions of CPU-hours required to complete statewide seismic hazard map calculations in planning.

Funding for this research was in part provided through XSEDE's Extended Collaborative Support Service (ECSS) program. "ECSS exists for exactly this reason—to help research teams make significant performance gains and take their simulations to the next level," said Nancy Wilkins-Diehr, co-director of the ECSS program and SDSC's associate director. "ECSS projects are typically conducted over several months to up to one year. This type of targeted support may be requested by anyone through the XSEDE allocations process."



A snapshot of simulated horizontal (east-west) ground motion of 2008's magnitude-5.4 Chino Hills, CA, earthquake. The red-yellow and green-blue colors depict the large and small amplitude of shaking; the star shows the earthquake's location. Courtesy of: Efecan Poyraz/UC San Diego, Kim Olsen/SDSU. Map image courtesy of: Google.