The next great quake

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The 2004 Sumatra-Andaman earthÂ-quake and reÂ-sultÂ-ing tsuÂ-naÂ-mi are inÂ-faÂ-mous for the deÂ-strucÂ-tion they wrought. But at the time, many sciÂ-enÂ-tists thought the arÂ-ea unÂ-likeÂ-ly to witÂ-ness a quake of such size.

Now, a geophysÂ-iÂ-cist is urgÂ-ing the pubÂ-lic and polÂ-iÂ-cyÂ-makÂ-ers to treat as â€œlocked, loadÂ-ed, and danÂ-gerÂ-ousâ€• all geÂ-oÂ-logÂ-iÂ-cal strucÂ-tures like the one that spawned that quake.These danÂ-ger zones are at tecÂ-tonÂ-ic boundÂ-aries, borÂ-ders beÂ-tween segÂ-ments of Earthâ€™s crust that gradÂ-uÂ-alÂ-ly move relÂ-aÂ-tive to each othÂ-er, acÂ-cordÂ-ing to the sciÂ-entÂ-ist, RobÂ-ert McÂ-CafÂ-frey of RensÂ-seÂ-laer PolÂ-yÂ-techÂ-nic InÂ-stiÂ-tute in Troy, N.Y.

A tsuÂ-naÂ-mi can ocÂ-cur when one of the many tecÂ-tonÂ-ic plates that make up Earthâ€™s outÂ-er shell deÂ-scends, or â€œsubÂ-ducts,â€• unÂ-der an adÂ-jaÂ-cent plate. Above, in the first step, the overÂ-ridÂ-ing plate, stuck to the subÂ-ductÂ-ing plate, gets squeezed. Its leadÂ-ing edge is dragged down, while an arÂ-ea beÂ-hind bulges upÂ-ward. This moveÂ-ment goes on for decÂ-ades or cenÂ-turies, slowÂ-ly buildÂ-ing up stress. An earthÂ-quake reÂ-sults when the leadÂ-ing edge of the overÂ-ridÂ-ing plate breaks free and springs upÂ-ward, raisÂ-ing the sea floor and the waÂ-ter above it. (CourÂ-teÂ-sy U.S. GeÂ-oÂ-logÂ-iÂ-cal SurÂ-vey)

McÂ-CafÂ-frey issued his warning in an arÂ-tÂ-iÂ-cle in the March 23 isÂ-sue of the reÂ-search jourÂ-nal SciÂ-ence.CulÂ-prits in the most powÂ-erÂ-ful quakes are typÂ-iÂ-calÂ-ly â€œsubÂ-ducÂ-tion-typeâ€• boundÂ-aries, he exÂ-plained. These are where one plate genÂ-tly slips unÂ-derÂ-neath anothÂ-er, causÂ-ing fricÂ-tion, crackÂ-ing, and liftÂ-ing of plates. Such zones are typÂ-iÂ-calÂ-ly reÂ-sponÂ-siÂ-ble for the magÂ-niÂ-tude 9 quakes, the most powÂ-erÂ-ful on recÂ-ord, McÂ-CafÂ-frey said.â€œSeisÂ-molÂ-oÂ-gists have long tried to deÂ-terÂ-mine which subÂ-ducÂ-tion boundÂ-aries are more likeÂ-ly than othÂ-ers to break,â€• he wrote. â€œYet, the great earthÂ-quake of 2004 rupÂ-tured a segÂ-ment that was thought to be among the least likeÂ-ly to go.â€•On Dec. 26 of that year, the earth unÂ-der the InÂ-diÂ-an Ocean buckÂ-led and broke, unÂ-leashÂ-ing one of hisÂ-toÂ-ryâ€™s worst quakes, logged at magÂ-niÂ-tude 9.2. Its shock waves creÂ-atÂ-ed a wall of rushÂ-ing waÂ-ter that shatÂ-tered comÂ-muÂ-niÂ-ties up to 1,000 miles away.A magÂ-niÂ-tude 9 event can reÂ-sult from just 20 meÂ-ters (22 yards) of slip beÂ-tween two conÂ-vergÂ-ing plates, less then the length of an 18-wheeler truckâ€”but its imÂ-pact can be globÂ-al, McÂ-CafÂ-frey said. Slips of this length onÂ-ly ocÂ-cur eveÂ-ry 200 to 1,000 years or more at a givÂ-en boundÂ-aÂ-ry, he added; comÂ-plete recÂ-ords of such events are availÂ-aÂ-ble for onÂ-ly the past cenÂ-tury. SciÂ-enÂ-tists had wideÂ-ly acÂ-ceptÂ-ed that the age and speed of the subÂ-ductÂ-ing plate is imÂ-porÂ-tant in creÂ-atÂ-ing magÂ-niÂ-tude 9 quakes, based priÂ-marÂ-iÂ-ly on this 100-year recÂ-ord. But this narÂ-row unÂ-derstanding put the SuÂ-maÂ-tran subÂ-ducÂ-tion zone in a very low risk catÂ-eÂ-goÂ-ry, McÂ-CafÂ-frey noted. Such limÂ-itÂ-ed recÂ-ords canâ€™t map a trend in events that could be sevÂ-erÂ-al cenÂ-turies or more apart, he added.In 2004, â€œEarth gave us a stark reÂ-minder of the imÂ-porÂ-tant difÂ-ferÂ-ence beÂ-tween imÂ-probÂ-aÂ-bilÂ-ity and imÂ-posÂ-siÂ-bilÂ-ity,â€• McÂ-CafÂ-frey wrote. â€œOur unÂ-derstanding of where and when the next great earthÂ-quake will hapÂ-pen is in its inÂ-fanÂ-cy at best.â€• SevÂ-erÂ-al subÂ-ducÂ-tion zones â€œare near denseÂ-ly popÂ-uÂ-lated land arÂ-eÂ-as, and the poÂ-tenÂ-tial imÂ-pacts of shakÂ-ing and tsuÂ-naÂ-mis canÂ-not be overÂ-statÂ-ed,â€• he added. WarnÂ-ing sysÂ-tems must be creÂ-atÂ-ed with inÂ-put and supÂ-port from many counÂ-tries, in adÂ-diÂ-tion to edÂ-uÂ-caÂ-tional outÂ-reach to coastÂ-al comÂ-muÂ-niÂ-ties, McÂ-CafÂ-frey said. â€œThese sysÂ-tems need to be strong and they need to be mainÂ-tained over the long term, beÂ-cause we have no way of knowÂ-ing when the next great earthÂ-quake will hit.â€•

Courtesy Rensselaer Polytechnic Instituteand World Science staff

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