HOW DID WE FIND OUT ABOUT EARTHQUAKES? pdf

1: San Francisco Earthquake of - HISTORY

You probably know that the Earth's crust is broken up into huge tectonic plates that slide under, over and past each other, slowly building mountains, forming new oceans and triggering earthquakes.

And what did they reveal? There are at least four different kinds of moonquakes: The first three were generally mild and harmless. Shallow moonquakes on the other hand were doozies. Between and , the Apollo seismic network saw twenty-eight of them; a few "registered up to 5. A magnitude 5 quake on Earth is energetic enough to move heavy furniture and crack plaster. Once they got going, all continued more than 10 minutes. On Earth, vibrations from quakes usually die away in only half a minute. The reason has to do with chemical weathering, Neal explains: When energy propagates across such a compressible structure, it acts like a foam spongeâ€”it deadens the vibrations. The moon, however, is dry, cool and mostly rigid, like a chunk of stone or iron. So moonquakes set it vibrating like a tuning fork. Representative lunar seismograms from the Apollo 16 station. And where do they occur? Neal and his colleagues are developing a proposal to deploy a network of 10 to 12 seismometers around the entire moon, to gather data for at least three to five years. This kind of work is necessary, Neal believes, to find the safest spots for permanent lunar bases. Other planets may be shaking, too: The Lunar Seismic Network: Mission Update Scientists find deeper meaning for Moon rumblings -- NY Times more information about deep rather than shallow moonquakes. New computers uncover old quakes on the Moon -- Discover Magazine Mr. Moonquake -- Yosio Nakamura, a colleague of Neal, is a leading authority on moonquakes.

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2: The structure of the Earth | Earthquakes | Discovering Geology | British Geological Survey (BGS)

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To figure out just where that earthquake happened, you need to look at your seismogram and you need to know what at least two other seismographs recorded for the same earthquake. You will also need a map of the world, a ruler, a pencil, and a compass for drawing circles on the map. Figure 1 - Our typical seismogram from before, this time marked for this exercise from Bolt, One minute intervals are marked by the small lines printed just above the squiggles made by the seismic waves the time may be marked differently on some seismographs. The distance between the beginning of the first P wave and the first S wave tells you how many seconds the waves are apart. This number will be used to tell you how far your seismograph is from the epicenter of the earthquake. In this case, the first P and S waves are 24 seconds apart. Find the point for 24 seconds on the left side of the chart below and mark that point. Measure the amplitude of the strongest wave. The amplitude is the height on paper of the strongest wave. On this seismogram, the amplitude is 23 millimeters. Find 23 millimeters on the right side of the chart and mark that point. Place a ruler or straight edge on the chart between the points you marked for the distance to the epicenter and the amplitude. The point where your ruler crosses the middle line on the chart marks the magnitude strength of the earthquake. This earthquake had a magnitude of 5. This is where the compass, the map, and the other seismograph records come in. Figure 3 - The point where the three circles intersect is the epicenter of the earthquake. It should look something like a piece of a ruler. All maps are different. On your map, one centimeter could be equal to kilometers or something like that. Figure out how long the distance to the epicenter in centimeters is on your map. For example, say your map has a scale where one centimeter is equal to kilometers. If the epicenter of the earthquake is kilometers away, that equals 2. Using your compass, draw a circle with a radius equal to the number you came up with in Step 2 the radius is the distance from the center of a circle to its edge. The center of the circle will be the location of your seismograph. The epicenter of the earthquake is somewhere on the edge of that circle. Do the same thing for the distance to the epicenter that the other seismograms recorded with the location of those seismographs at the center of their circles. All of the circles should overlap. The point where all of the circles overlap is the approximate epicenter of the earthquake.

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3: 3 Ways to Know Naturally when an Earthquake Will Strike - wikiHow

Isaac Asimov was a Russian-born, American author, a professor of biochemistry, and a highly successful writer, best known for his works of science fiction and for his popular science books. Professor Asimov is generally considered one of the most prolific writers of all time, having written or.

Naturally occurring earthquakes Fault types Tectonic earthquakes occur anywhere in the earth where there is sufficient stored elastic strain energy to drive fracture propagation along a fault plane. The sides of a fault move past each other smoothly and aseismically only if there are no irregularities or asperities along the fault surface that increase the frictional resistance. Most fault surfaces do have such asperities and this leads to a form of stick-slip behavior. Once the fault has locked, continued relative motion between the plates leads to increasing stress and therefore, stored strain energy in the volume around the fault surface. This continues until the stress has risen sufficiently to break through the asperity, suddenly allowing sliding over the locked portion of the fault, releasing the stored energy. This process of gradual build-up of strain and stress punctuated by occasional sudden earthquake failure is referred to as the elastic-rebound theory. Fault geology There are three main types of fault, all of which may cause an interplate earthquake: Normal and reverse faulting are examples of dip-slip, where the displacement along the fault is in the direction of dip and movement on them involves a vertical component. Normal faults occur mainly in areas where the crust is being extended such as a divergent boundary. Reverse faults occur in areas where the crust is being shortened such as at a convergent boundary. Strike-slip faults are steep structures where the two sides of the fault slip horizontally past each other; transform boundaries are a particular type of strike-slip fault. Many earthquakes are caused by movement on faults that have components of both dip-slip and strike-slip; this is known as oblique slip. Reverse faults, particularly those along convergent plate boundaries are associated with the most powerful earthquakes, megathrust earthquakes , including almost all of those of magnitude 8 or more. Strike-slip faults, particularly continental transforms , can produce major earthquakes up to about magnitude 8. Earthquakes associated with normal faults are generally less than magnitude 7. For every unit increase in magnitude, there is a roughly thirtyfold increase in the energy released. For instance, an earthquake of magnitude 6. Therefore, the longer the length and the wider the width of the faulted area, the larger the resulting magnitude. Rocks hotter than about degrees Celsius flow in response to stress; they do not rupture in earthquakes. Examples are the earthquakes in Chile, ; Alaska, ; Sumatra, , all in subduction zones. The longest earthquake ruptures on strike-slip faults, like the San Andreas Fault , , the North Anatolian Fault in Turkey and the Denali Fault in Alaska , are about half to one third as long as the lengths along subducting plate margins, and those along normal faults are even shorter. Aerial photo of the San Andreas Fault in the Carrizo Plain , northwest of Los Angeles The most important parameter controlling the maximum earthquake magnitude on a fault is however not the maximum available length, but the available width because the latter varies by a factor of Along converging plate margins, the dip angle of the rupture plane is very shallow, typically about 10 degrees. Thrust faults are generated by the highest, strike slip by intermediate, and normal faults by the lowest stress levels. In the case of normal faults, the rock mass is pushed down in a vertical direction, thus the pushing force greatest principal stress equals the weight of the rock mass itself. Strike-slip faulting is intermediate between the other two types described above. This difference in stress regime in the three faulting environments can contribute to differences in stress drop during faulting, which contributes to differences in the radiated energy, regardless of fault dimensions. Earthquakes away from plate boundaries Main article: In the case of the San Andreas fault continental transform, many earthquakes occur away from the plate boundary and are related to strains developed within the broader zone of deformation caused by major irregularities in the fault trace e. The Northridge earthquake was associated with movement on a blind thrust within such a zone. Another example is the strongly oblique convergent plate boundary between the Arabian and Eurasian plates where it runs through the northwestern part of the Zagros Mountains. The deformation associated with this plate boundary is partitioned into nearly pure thrust sense movements perpendicular to the boundary over a wide zone to the southwest and nearly pure strike-slip motion along the

Main Recent Fault close to the actual plate boundary itself. This is demonstrated by earthquake focal mechanisms. The majority of tectonic earthquakes originate at the ring of fire in depths not exceeding tens of kilometers. Deep-focus earthquakes occur at a depth where the subducted lithosphere should no longer be brittle, due to the high temperature and pressure. A possible mechanism for the generation of deep-focus earthquakes is faulting caused by olivine undergoing a phase transition into a spinel structure. Volcano tectonic earthquake Earthquakes often occur in volcanic regions and are caused there, both by tectonic faults and the movement of magma in volcanoes. Such earthquakes can serve as an early warning of volcanic eruptions, as during the eruption of Mount St. These swarms can be recorded by seismometers and tiltmeters a device that measures ground slope and used as sensors to predict imminent or upcoming eruptions. The scale of the nucleation zone is uncertain, with some evidence, such as the rupture dimensions of the smallest earthquakes, suggesting that it is smaller than m while other evidence, such as a slow component revealed by low-frequency spectra of some earthquakes, suggest that it is larger. Once the rupture has initiated, it begins to propagate along the fault surface. The mechanics of this process are poorly understood, partly because it is difficult to recreate the high sliding velocities in a laboratory. Also the effects of strong ground motion make it very difficult to record information close to a nucleation zone. The rupture velocity is a function of the fracture energy in the volume around the crack tip, increasing with decreasing fracture energy. The velocity of rupture propagation is orders of magnitude faster than the displacement velocity across the fault. A small subset of earthquake ruptures appear to have propagated at speeds greater than the S-wave velocity. These supershear earthquakes have all been observed during large strike-slip events. The unusually wide zone of coseismic damage caused by the Kunlun earthquake has been attributed to the effects of the sonic boom developed in such earthquakes. Some earthquake ruptures travel at unusually low velocities and are referred to as slow earthquakes. A particularly dangerous form of slow earthquake is the tsunami earthquake , observed where the relatively low felt intensities, caused by the slow propagation speed of some great earthquakes, fail to alert the population of the neighboring coast, as in the Sanriku earthquake. Earthquake clusters Most earthquakes form part of a sequence, related to each other in terms of location and time. An aftershock is an earthquake that occurs after a previous earthquake, the mainshock. An aftershock is in the same region of the main shock but always of a smaller magnitude. If an aftershock is larger than the main shock, the aftershock is redesignated as the main shock and the original main shock is redesignated as a foreshock. Aftershocks are formed as the crust around the displaced fault plane adjusts to the effects of the main shock. Earthquake swarm Earthquake swarms are sequences of earthquakes striking in a specific area within a short period of time. They are different from earthquakes followed by a series of aftershocks by the fact that no single earthquake in the sequence is obviously the main shock, therefore none have notable higher magnitudes than the other. An example of an earthquake swarm is the activity at Yellowstone National Park. Similar to aftershocks but on adjacent segments of fault, these storms occur over the course of years, and with some of the later earthquakes as damaging as the early ones. Such a pattern was observed in the sequence of about a dozen earthquakes that struck the North Anatolian Fault in Turkey in the 20th century and has been inferred for older anomalous clusters of large earthquakes in the Middle East. Prior to the development of strong-motion accelerometers that can measure peak ground speed and acceleration directly, the intensity of the earth-shaking was estimated on the basis of the observed effects, as categorized on various seismic intensity scales. Subsequent scales see seismic magnitude scales have retained a key feature, where each unit represents a ten-fold difference in the amplitude of the ground shaking, and a fold difference in energy. Subsequent scales are also adjusted to have approximately the same numeric value within the limits of the scale. About , of these can be felt. The Messina earthquake and tsunami took as many as , lives on December 28, in Sicily and Calabria. As a result, many more earthquakes are reported than in the past, but this is because of the vast improvement in instrumentation, rather than an increase in the number of earthquakes. The United States Geological Survey estimates that, since , there have been an average of 18 major earthquakes magnitude 7. However, accurate recordings of earthquakes only began in the early s, so it is too early to categorically state that this is the case. Four main activities contribute to this phenomenon: The city of Newcastle was built over a large sector of coal mining areas. The earthquake has been reported to be spawned from a fault that reactivated due to the millions of

tonnes of rock removed in the mining process. Seismic magnitude scales and Seismology The instrumental scales used to describe the size of an earthquake began with the Richter magnitude scale in the s. The surface wave magnitude was developed in the s as a means to measure remote earthquakes and to improve the accuracy for larger events. The moment magnitude scale measures the amplitude of the shock, but also takes into account the seismic moment total rupture area, average slip of the fault, and rigidity of the rock. The Japan Meteorological Agency seismic intensity scale , the Medvedevâ€"Sponheuerâ€"Karnik scale , and the Mercalli intensity scale are based on the observed effects and are related to the intensity of shaking. Every tremor produces different types of seismic waves, which travel through rock with different velocities: Longitudinal P-waves shock- or pressure waves Transverse S-waves both body waves Surface waves â€" Rayleigh and Love waves Propagation velocity of the seismic waves ranges from approx. The differences in travel time from the epicenter to the observatory are a measure of the distance and can be used to image both sources of quakes and structures within the Earth. Also, the depth of the hypocenter can be computed roughly. On average, the kilometer distance to the earthquake is the number of seconds between the P and S wave times 8. S waves and later arriving surface waves do main damage compared to P waves. P wave squeezes and expands material in the same direction it is traveling. S wave shakes the ground up and down and back and forth. The world is divided into Flinnâ€"Engdahl regions F-E regions , which are based on political and geographical boundaries as well as seismic activity. More active zones are divided into smaller F-E regions whereas less active zones belong to larger F-E regions. Standard reporting of earthquakes includes its magnitude , date and time of occurrence, geographic coordinates of its epicenter , depth of the epicenter, geographical region, distances to population centers, location uncertainty, a number of parameters that are included in USGS earthquake reports number of stations reporting, number of observations, etc. A tsunami overwhelms the ships in the harbor. The effects of earthquakes include, but are not limited to, the following: Shaking and ground rupture are the main effects created by earthquakes, principally resulting in more or less severe damage to buildings and other rigid structures. The severity of the local effects depends on the complex combination of the earthquake magnitude , the distance from the epicenter , and the local geological and geomorphological conditions, which may amplify or reduce wave propagation. Specific local geological, geomorphological, and geostructural features can induce high levels of shaking on the ground surface even from low-intensity earthquakes. This effect is called site or local amplification. It is principally due to the transfer of the seismic motion from hard deep soils to soft superficial soils and to effects of seismic energy focalization owing to typical geometrical setting of the deposits. Ground rupture is a major risk for large engineering structures such as dams , bridges and nuclear power stations and requires careful mapping of existing faults to identify any which are likely to break the ground surface within the life of the structure. Landslide Earthquakes, along with severe storms, volcanic activity, coastal wave attack, and wildfires, can produce slope instability leading to landslides, a major geological hazard. Landslide danger may persist while emergency personnel are attempting rescue. In the event of water mains rupturing and a loss of pressure, it may also become difficult to stop the spread of a fire once it has started. For example, more deaths in the San Francisco earthquake were caused by fire than by the earthquake itself. Soil liquefaction Soil liquefaction occurs when, because of the shaking, water-saturated granular material such as sand temporarily loses its strength and transforms from a solid to a liquid.

HOW DID WE FIND OUT ABOUT EARTHQUAKES? pdf

4: Earthquake - Wikipedia

As in his other How Did We Find Out books, Asimov begins with the beliefs of primitives and ancients; later come summaries of other theories that "didn't work out" either, plus a synopsis of landmarks in the development and application of the seismograph.

According to the United States Geological Survey: The earthquake reflects tectonic stresses resulting from the convergence of crustal material slowly moving from the high Tibetan Plateau , to the west, against strong crust underlying the Sichuan Basin and southeastern China. The convergence of the two plates is broadly accommodated by the uplift of the Asian highlands and by the motion of crustal material to the east away from the uplifted Tibetan Plateau. The northwestern margin of the Sichuan Basin has previously experienced destructive earthquakes. According to the British Geological Survey: Earthquakes of this size have the potential to cause extensive damage and loss of life. The earthquake occurred as a result of motion on a northeast striking thrust fault that runs along the margin of the basin. This deformation also results in the extrusion of crustal material from the high Tibetan Plateaux in the west towards the Sichuan Basin and southeastern China. China frequently suffers large and deadly earthquakes. In August , the magnitude 7. Recent alerts can be found on the web page of the International Institute for Earth Simulation Foundation http: Such an alert was issued 21 minutes after the May 12 Wenchuan earthquake of It had at first been assigned M7. This initial underestimate of the magnitude is a known problem with earthquakes of M8 and larger. Based on the M7. After learning that the earthquake may measure M8, QLARM distributed a revised estimate of 40, to , fatalities. This information was distributed within minutes of the Wenchuan earthquake. The news and official reports of fatalities are often strongly misleading. After the Wenchuan earthquake, officials led the public to believe for more than a week that the fatalities numbered only a fraction of what they really were Figure 1. At the very beginning, everyone expects the news reports to be an initial count that will grow, not however, after one week. After such a long time, the false news reports take on a reality in their own right and the theoretical loss calculations by experts are discarded. Official fatality reports for the Wenchuan M8 earthquake as a function of time. Squares show fatalities, triangles show the sum of fatalities plus missing persons, which equaled the number of fatalities in the end. The diamond is the QLARM estimate minutes after the earthquake, with the range of possible values given by the solid, vertical line through the diamond. Map of settlements with the estimated mean damage due to the Wenchuan earthquake modeled as a line rupture extending as far as the aftershocks. Once the extent of the rupture of the Wenchuan earthquake became known, QLARM calculated a more detail picture of the losses. Figure 2 shows a map of the expected mean damage of the settlements affected by the Wenchuan earthquake on a scale of 5. The resistance to shaking of buildings in large cities is assumed to be stronger than in villages, therefore the damage and percentage of fatalities in large cities is less than in villages. List of Sichuan earthquake aftershocks On the night of May 12, residents of Chengdu worried about potential aftershocks gathered in the street to avoid staying in buildings. Between 64 and major aftershocks, ranging in magnitude from 4. According to Chinese official counts, "by See Panzhihua earthquake for details. Extent of the tremors[edit] Places ordered by distance from epicenter or time of propagation: All provincial-level divisions except Xinjiang , Jilin and Heilongjiang were physically affected by the quake. Tremors were felt approximately three minutes after the quake, continuing for about half a minute. This was also the most distant earthquake known ever to be felt in Hong Kong. Tremors were felt approximately three minutes after the quake. Tremors were felt approximately five minutes after the earthquake in northern parts of Vietnam. In parts of Thailand tremors were felt six minutes after the quake. Office buildings in Bangkok swayed for the next several minutes. It took about eight minutes for the quake to reach Taiwan, where the tremors continued for one to two minutes; no damage or injuries were reported. Tremors were felt approximately eight minutes after the earthquake in parts of Mongolia. Tremors were felt eight and a half minutes after the quake in all parts of Bangladesh. Tremors were felt approximately eight and a half minutes after the quake. Tremors were felt approximately nine minutes after the earthquake in parts of India. In parts of Northern Pakistan tremors were felt ten minutes after the quake. Tremors were felt in Tuva ,

no casualties reported. One SilkAir flight was diverted and landed in Kunming as a result. Chengdu Shuangliu Airport reopened later on the evening of May 12, offering limited service as the airport began to be used as a staging area for relief operations. None of the Olympic venues were damaged. All of the highways into Wenchuan , and others throughout the province, were damaged, resulting in delayed arrival of the rescue troops. The Juyuan Middle School , where many teenagers were buried, was excavated by civilians and cranes. A girl was found alive in the ruins hours 4 days, 6 hours after the earthquake. Copper rose over speculations that production in southwestern China may be affected, [59] and oil prices dropped over speculations that demand from China would fall. Elements of telecommunications were restored by the government piece by piece over the next number of months as the situation in the Sichuan province gradually improved. Eventually, a handful of major news and media websites were made accessible online in the region, albeit with dramatically pared back webpages. China Mobile had more than 2, base stations suspended due to power disruption or severe telecommunication traffic congestion. Half of the wireless communications were lost in the Sichuan province. Initially, officials were unable to contact the Wolong National Nature Reserve , home to around giant pandas. Nonetheless, the well-being of an even greater number of pandas in the neighbouring panda reserves remained unknown. Five security guards at the reserve were killed by the earthquake. By May 20, two pandas at the reserve were found to be injured, while the search continued for another two adult pandas that went missing after the quake. Panda keepers and other workers placed her remains in a small wooden crate and buried her outside the breeding centre. The Zipingpu Hydropower Plant simplified Chinese: A recent inspection indicated that the damage was less severe than initially feared, and it remains structurally stable and safe. About 2, troops have been allocated to Zipingpu, trying to release the pressure through spillway. In total, dams, most of them small, were reported damaged by the quake.

HOW DID WE FIND OUT ABOUT EARTHQUAKES? pdf

5: HOW DID WE FIND OUT ABOUT EARTHQUAKES? by Isaac Asimov | Kirkus Reviews

Questions and answers about Did You Feel It? Scientific Background Explore our collection of citizen science data, report your experience of an earthquake, or learn more about this citizen science project - how it's done, how you can contribute, and what we do with your data.

Why Do Earthquakes Happen? Earthquakes are usually caused when rock underground suddenly breaks along a fault. This sudden release of energy causes the seismic waves that make the ground shake. When two blocks of rock or two plates are rubbing against each other, they stick a little. The rocks are still pushing against each other, but not moving. When the rocks break, the earthquake occurs. During the earthquake and afterward, the plates or blocks of rock start moving, and they continue to move until they get stuck again. The spot underground where the rock breaks is called the focus of the earthquake. The place right above the focus on top of the ground is called the epicenter of the earthquake. Try this little experiment: Break a block of foam rubber in half. Put the pieces on a smooth table. Put the rough edges of the foam rubber pieces together. While pushing the two pieces together lightly, push one piece away from you along the table top while pulling the other piece toward you. See how they stick? Keep pushing and pulling smoothly. Soon a little bit of foam rubber along the crack the fault will break and the two pieces will suddenly slip past each other. That sudden breaking of the foam rubber is the earthquake. Earthquake-like seismic waves can also be caused by explosions underground. These explosions may be set off to break rock while making tunnels for roads, railroads, subways, or mines. You may not even feel them. Sometimes seismic waves occur when the roof or walls of a mine collapse. These can sometimes be felt by people near the mine. The largest underground explosions, from tests of nuclear warheads bombs , can create seismic waves very much like large earthquakes. This fact has been exploited as a means to enforce the global nuclear test ban, because no nuclear warhead can be detonated on earth without producing such seismic waves.

6: Did You Feel It?

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7: How Earthquakes Work | HowStuffWorks

The title of each book in the series, which was originally suggested by my editor was to begin How Did We Find Out. They were to deal with science history on a junior high school level. They were to deal with science history on a junior high school level.

8: Sichuan earthquake - Wikipedia

earthquakes, popular science, english, isaac asimov, sujata godbole Skip to main content Search the history of over billion web pages on the Internet.

9: Moonquakes | Science Mission Directorate

Northern California has had: (M or greater) 9 earthquakes in the past 24 hours 71 earthquakes in the past 7 days; earthquakes in the past 30 days.

HOW DID WE FIND OUT ABOUT EARTHQUAKES? pdf

Installing Windows Vista Register of Confederate soldiers who died in Camp Douglas, 1862-65 Biotechnology and cleaner production in Canada In this House of Brede Operation II Duce (Dales Mystery) Early positivism and legal realism Lady Good-for-Nothing (Large Print Edition) The effects of an educational planning unit on eighth-grade students Bewitched bothered and bewildered sheet music What are some of the weapons of spiritual warfare? Teacher leadership : ideology and practice Ann Lieberman, Ellen R. Saxl, and Matthew B. Miles No pain like this body. Rebellion in the borderlands Kenichi yamamoto rotary engine Productivity slowdown and financial tensions 2. A contextual analysis of Xhosa iimbongi and their izibongo Russell H. Kaschula St. Helena during Napoleons exile: Gorrequers diary. The Doctors Fire Rescue Contemporary composers Guide to oral history collections in Canada Indigenous Peoples and Human Rights (Melland Schill Studies in International Law) Final fantasy xii piano collections sheet music torrent Booming steel town Rationalising the law and ethics of consent Workbooks in Primary English (Workbooks In Primary English) Quest for church unity Museum of modern art The Discrepancy Between the Public and the Private Selves of Indonesian Women Health priorities for the older adult The Autobiography of an Unkown Indian Undertale art book 4chan Lay Teachers in Catholic Higher Education, An Emerging Paradigm For The Twenty-First Century Taking of Getty Oil Mary Ann Lang. Message from the President of the United States, returning House bill no. 7907, with his o The Cooper Clinic Solution to the Diet Revolution Intelligence came first Twinkle little star Key Stage 3 English Kit Year 7 Introduction to the intertestamental period Lucy growing up human