DOWNLOAD PDF EARTHS CREEPING CRUST

Chapter 1 : FACT CHECK: Do Dramatic Videos Show the Earthâ€™s Crust â€œMovingâ€• for the â€œFir

As the slowly moving and creeping crust approaches an existing continent, however, (the right side of the graphic), eroded rock from the continent washes into the sea from rainfall, ice glaciers, wind, etc.

This is because of the relative melting points of the different layers nickelâ€”iron core, silicate crust and mantle and the increase in temperature and pressure as depth increases. At the surface both nickelâ€”iron alloys and silicates are sufficiently cool to be solid. In the upper mantle, the silicates are generally solid localised regions with small amounts of melt exist ; however, as the upper mantle is both hot and under relatively little pressure, the rock in the upper mantle has a relatively low viscosity. In contrast, the lower mantle is under tremendous pressure and therefore has a higher viscosity than the upper mantle. The metallic nickelâ€”iron outer core is liquid because of the high temperature, despite the high pressure. As the pressure increases, the nickelâ€”iron inner core becomes solid because the melting point of iron increases dramatically at these high pressures. Mantle convection This figure is a snapshot of one time-step in a model of mantle convection. Colors closer to red are hot areas and colors closer to blue are cold areas. In this figure, heat received at the coreâ€”mantle boundary results in thermal expansion of the material at the bottom of the model, reducing its density and causing it to send plumes of hot material upwards. Likewise, cooling of material at the surface results in its sinking. Downward motion of material occurs at convergent plate boundaries called subduction zones. Locations on the surface that lie over plumes are predicted to have high elevation because of the buoyancy of the hotter, less-dense plume beneath and to exhibit hot spot volcanism. The volcanism often attributed to deep mantle plumes is alternatively explained by passive extension of the crust, permitting magma to leak to the surface the "Plate" hypothesis. Plate motion should not be confused with continental drift which applies purely to the movement of the crustal components of the continents. The movements of the lithosphere and the underlying mantle are coupled since descending lithosphere is an essential component of convection in the mantle. Although there is a tendency to larger viscosity at greater depth, this relation is far from linear and shows layers with dramatically decreased viscosity, in particular in the upper mantle and at the boundary with the core. The mantle is considered to be viscous and incapable of brittle faulting. A number of mechanisms have been proposed to explain this phenomenon, including dehydration, thermal runaway, and phase change. Thus, the upper mantle can only flow very slowly. However, when large forces are applied to the uppermost mantle it can become weaker, and this effect is thought to be important in allowing the formation of tectonic plate boundaries. Exploration Exploration of the mantle is generally conducted at the seabed rather than on land because of the relative thinness of the oceanic crust as compared to the significantly thicker continental crust. The first attempt at mantle exploration, known as Project Mohole , was abandoned in after repeated failures and cost over-runs. On 5 March , a team of scientists on board the RRS James Cook embarked on a voyage to an area of the Atlantic seafloor where the mantle lies exposed without any crust covering, midway between the Cape Verde Islands and the Caribbean Sea. The exposed site lies approximately three kilometres beneath the ocean surface and covers thousands of square kilometres. This is nearly three times as deep as preceding oceanic drillings. A novel method of exploring the uppermost few hundred kilometres of the Earth was proposed in , consisting of a small, dense, heat-generating probe which melts its way down through the crust and mantle while its position and progress are tracked by acoustic signals generated in the rocks. In , a supercomputer application provided new insight into the distribution of mineral deposits, especially isotopes of iron, from when the mantle developed 4.

Chapter 2 : A Mineral Is Stealing Iron From Earth's Crust

Let us now examine our planet's outer layers in more detail. Earth's crust is a dynamic place. Volcanic eruptions, erosion, and large-scale movements of the continents rework the surface of our planet constantly.

Like all the other terrestrial planets , Mercury, Venus, and Mars the Earth is made up of many layers. This is the result of it undergoing planetary differentiation, where denser materials sink to the center to form the core while lighter materials form around the outside. Information about structure and composition of the mantle is either the result of geophysical investigation or from direct analysis of rocks derived from the mantle, or exposed mantle on the ocean floor. While it is predominantly solid, it behaves like a viscous fluid due to the fact that temperatures are close to the melting point in this layer. The layers of the Earth, a differentiated planetary body. The mantle is divided into sections which are based upon results from seismology. These are the upper mantle, which extends from about 7 to 35 km 4. In the upper mantle two main zones are distinguished. The innermost of these is the inner asthenosphere, which is composed of plastic flowing rock of that averages about km mi in thickness. The outer zone is the lowermost part of the lithosphere, which is composed of rigid rock and is about 50 to km 31 to 75 mi thick. The internal structure of Earth. There are also a few places on land where mantle rock has been pushed to the surface by tectonic activity, most notably the Tablelands region of Gros Morne National Park in Newfoundland and Labrador, Canada, St. In terms of its constituent elements, the mantle is made up of These elements are all bound together in the form of silicate rocks, all of which take the form of oxides. Examples of rocks that you might find inside the mantle include: Whereas hot material rises to the surface, cooler, heavier material sinks beneath. Public Domain The lithosphere is divided into a number of plates that are continuously being created and consumed at their opposite plate boundaries. Downward motion of material occurs in subduction zones, locations at convergent plate boundaries where one mantle layer moves under another. Accretion occurs as material is added to the growing edges of a plate, associated with seafloor spreading. This chaotic process is believed to be an integral part of the motion of plates, which in turn gives rise to continental drift. Subducted oceanic crust is also what gives rise to volcanism, as demonstrated by the Pacific Ring of Fire. Scientific investigations and exploration of the mantle is generally conducted on the seabed due to the relative thickness of the oceanic crust compared to the continental crust. The first attempt at mantle exploration known as Project Mohole achieved a deepest penetration of approximately meters feet. It was abandoned in after repeated failures and cost over-runs. This would melt its way through the crust and mantle and communicate via acoustic signals generated by its penetration of the rocks. The probe would consist of an outer shell of tungsten with a core of cobalt, which acts as a radioactive heat source. In , a supercomputer application created a simulation that provided new insight into the distribution of mineral deposits from when the mantle developed 4. As human exploration of the Solar System continues, we are sure to learn more about terrestrial planets, their geological behavior, and their formation. Astronomy Cast also has an episodes on the subject. Listen to it here, Episode

Chapter 3 : Crust (geology) - Wikipedia

The Earth's crust is an extremely thin layer of rock that makes up the outermost solid shell of our planet. In relative terms, it's thickness is like that of the skin of an apple. It amounts to less than half of 1 percent of the planet's total mass but plays a vital role in most of Earth's natural.

References What is Creep? Most faults remain locked during the interval between earthquakes as elastic shear strain in the upper crust builds to a critical stress threshold when elastic strain energy is ultimately released by seismic fault slip i. Generalized block diagram illustrating elastic strain buildup on a strike-slip fault that occurs between large, stress-releasing earthquakes. Elastic strain along faults in the upper crust is driven by "continuous" fault movements along aseismic, ductile shear zones in the lower crust. The Causes of Creep The causes of fault creep have been the subject of much study, but are most commonly attributed to factors such as low frictional strength on the fault, the low values of normal stress acting on the fault in the shallow crust, and elevated pore-fluid pressures, which act to decrease the effective normal stress on a fault. Generalized block diagram illustrating the relation between creep and elastic strain Figure 1. Click on Figure for larger version. The Importance of Creep Data Because creep is an indicator of the shear strain on a fault, knowing how creep rates vary temporally and spatially along faults in the San Francisco Bay area has important implications for forecasting the timing, locations, and potential sizes of future earthquakes and for understanding the mechanics of fault behavior. For example, we now know that creep rates are sensitive to stress changes in the crust induced by moderate to large earthquakes on neighboring faults in the region Galehouse, ; Lienkaemper et al. Differences between creep rates measured locally along a fault and elastic strain rates measured by more regional geodetic data are also a proxy indicators of locking depth, so creep data can be used to modify seismic hazard estimations, which rely on knowing the thickness of crust that will likely experience the greatest strain release i. Their models suggest that locking depths vary along fault strike from km. Finally, creep-rate anomalies that may show up with continued monitoring might have potential for actually predicting the location and timing of future earthquakes. How We Measure Creep Geodetic monitoring of fault creep is usually accomplished using surveys of alinement arrays or trilateration networks or with creep meters. Creep meters can obtain micron precision e. Trilateration networks commonly overestimate creep because they span distances of hundreds of meters to kilometers, and therefore they tend to include elastic strain that occurs away from the fault. We monitor creep with theodolite surveys of alinement arrays. Alinement arrays Figure 3 provide the most accurate and complete measurements of creep because they are generally wide enough typically m to span the entire creeping zone, but narrow enough to exclude significant elastic strain away from the fault. An alinement array consists of three fixed points marked on permanent survey monuments or in some cases, nails driven into concrete or pavement. A high-precision theodolite Wild T is centered and leveled over a point IS on one side of the fault and a second target is centered and leveled over an orientation point OS on the same side of the fault as the theodolite. A third target is centered and leveled over an end point ES on the opposite side of the fault. The array is designed so that the IS-ES bearing is as close to perpendicular to fault strike as possible. The amount of creep is determined from the change in the angle between the IS-ES and IS-OS directions delta-theta that occurs between successive surveys at the site Figure 4. The IS-ES distance does not change significantly over time, but has been precisely measured with the electronic distance measurer EDM compontent of the T total station.. Geometric relations for determining the amount of creep that occurs between successive alinement array surveys. Theta1 is measured during the previous survey at the site. Theta2 is measured during a subsequent survey. If the IS-ES direction is not perpendicular to fault strike, then u must be trigonometrically corrected so that ucorrected is resolved in a direction that is parallel to fault strike. Geometric relations for correcting the measurement of creep for the case when the IS-ES direction is not perpendicular to fault strike. Note that u and ucorrected are greatly exaggerated with respect to the IS-ES distance, and so alpha and minus-alpha are essentially equal. We shade the instrument with a canopy during surveys to minimize instrument drift related to fluctuating temperatures. We make multiple sets of measurements during each survey at a site to quantify measurement uncertainties. Two sets of initial azimuth readings are initially taken alternately from the instrument IS to the orientation and end points OS and ES, respectively; Figure 3. The azimuth readings to each of the the two points must must agree to within 0. The theodolite is then flipped vertically degrees and the process is repeated producing a total of 4 angle measurements. We then rotate horizontally the tribraches i. This proceedure is designed to account for instrumental and target setup errors as much as possible. Standard deviations 1-sigma uncertainties are then calculated from the 8 angle measurements and these error estimates are then applied to the calculations of creep. The precision of the method is such that we can confidently detect any movement greater than mm between successive surveys. All creep rates reported on this website are least squares average rates determined by linear regression. For simplicity we do not show measurement errors for the creep data plots on this website. However, an example of how the standard deviations commonly compare to the creep measurement signal is shown below for data collected at site H8 HRKT on map of creep measurement sites on the Hayward fault in Fremont between and Figure 6. Creep data plot for site H8 HRKT on map of creep measurment sites on the Hayward fault, in Fremont, CA showing one standard deviation error bars for creep measurements. Inspection of the 1 sigma error bars indicates that the site noise is not an artifact of measurement uncertainties and that the error estimates are very small relative to the overall creep signal. Alternatively, the site noise is almost certainly related to the response of soil i. Similar climatic effects on the creep signal have been documented along the Parkfield segment of the San Andreas fault Roeloffs, Figure 7 illustrates how site noise and short-term records of apparent creep are influenced by variations soil moisture content. The graph shows, nearly without exception, that the onset of the rainy season marks the transitions from apparent left-lateral creep recorded during the dry Summer and early Fall months to apparent levels of right-lateral creep recorded after the ground begins to moisten with the first rains. Many of our data plots show this type of site noise, and in most cases, the noise is probably due to this same phenomenon. The graph also illustrates how long-term monitoring of creep is necessary to accurately characterize creep rates and to potentially recognize anomalous creep behavior. Types of Creep Behavior Details of creep behavior vary broadly from site to site, but most sites show patterns of creep that resemble one of three different types of creep; steady-state Figure 8 , episodic Figure 9 , and episodic with steady-state background creep Figure Some sites also show different types of creep behavior during differrent time intervals. In addition, triggerred slip and longer-term changes in creep rates have been recognized and shown to coincide with moderate to large earthquakes in the region, such as the Morgan Hill and Loma Prieta earthquakes Galehouse, , ; Galehouse and Lienkaemper, ; Lienkaemper et al. Triggered slip can occur at the time of the distant earthquake due to transient, dynamic stress changes associated with the passing of seismic waves e. Creep behavior at site CV7S along the Calaveras fault, near Holister see map of creep measurement sites , appears to show evidence of the effects of both dynamic and static stress changes associated with the Loma Prieta earthquake. To access up-to-date creep data and data plots for all of our sites, go to http: Model for steady-state creep average creep rate of 5. Steady-state creep is charaterized by a linear relation of creep through time. Sites that appear to show this type of behavior or intervals of this behavior include most sites along the Hayward fault, several sites on the Calaveras fault, and SAMV on the San Andreas fault see map of creep measurement sites. However, the steady-state signals are often obscurred by site noise. This type of creep is characterized by distinct creep events that are often separated by similar time intervals. This pattern of creep resembles frictional, stick-slip fault behavior. Sites that show this type of behavior include our Concord fault sites and CV7S along the Calaveras fault in Holister, CA see map of creep measurement sites. Sites that show intervals of this type of behavior include sites along the Concord fault. References Bilham, R, N. California creep meters, Seism. Slip triggered on the southern California faults by the Landers earthquake sequence, Bull. Effect of Loma Prieta earthquake on surface slip along the Calaveras fault in the Hollister area, Geophys. Inferences drawn from two decades of alinement array measurements of creep on faults in the San Francisco Bay region, Bull. Creep response of the Hayward fault to stress changes caused by the Loma Prieta earthquake, Science , Lon-term monitoring of creep rate along the Hayward fault and evidence for a lasting creep response to the Loma Prieta earthquake, Geophys. Creep rate changes at Parkfield, California, Inferred depth of creep on the Hayward fault, central California, J. Variations in creep rate along the Hayward fault, California, interpreted as changes in depth of creep,

Geophys. Response of the San Andreas fault to the Coalinga-Nunez earthquakes:

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Chapter 4 : Creeping Crust Cobbler | The North American Raspberry & Blackberry Association

"Crust," geologically speaking, refers to the layer of rock that surrounds our planet and rests on the more ductile mantle below. Discussion of the movement of crust generally occurs on either.

Estimates of average density for the upper crust range between 2. Formation of the Earth Earth formed approximately 4. It formed via accretion, where planetesimals and other smaller rocky bodies collided and stuck, gradually growing into a planet. This process generated an enormous amount of heat, which caused early Earth to melt completely. As planetary accretion slowed, Earth began to cool, forming its first crust, called a primary or primordial crust. Since then, Earth has been forming secondary and tertiary crust. Secondary crust forms at mid-ocean spreading centers, where partial-melting of the underlying mantle yields basaltic magmas and new ocean crust forms. This "ridge push" is one of the driving forces of plate tectonics, and it is constantly creating new ocean crust. That means that old crust must be destroyed somewhere, so, opposite a spreading center, there is usually a subduction zone: This constant process of creating new ocean crust and destroying old ocean crust means that the oldest ocean crust on Earth today is only about million years old. In contrast, the bulk of the continental crust is much older. The oldest continental crustal rocks on Earth have ages in the range from about 3. Some zircon with age as great as 4. Such old continental crust and the underlying mantle asthenosphere are less dense than elsewhere in Earth and so are not readily destroyed by subduction. Formation of new continental crust is linked to periods of intense orogeny ; these periods coincide with the formation of the supercontinents such as Rodinia , Pangaea and Gondwana. The crust forms in part by aggregation of island arcs including granite and metamorphic fold belts, and it is preserved in part by depletion of the underlying mantle to form buoyant lithospheric mantle. Geology of the Moon A theoretical protoplanet named " Theia " is thought to have collided with the forming Earth, and part of the material ejected into space by the collision accreted to form the Moon. The cumulate rocks form much of the crust. Most of this plagioclase-rich crust formed shortly after formation of the moon, between about 4. The best-characterized and most voluminous of these later additions are the mare basalts formed between about 3. Minor volcanism continued after 3. There is no evidence of plate tectonics. Study of the Moon has established that a crust can form on a rocky planetary body significantly smaller than Earth. Although the radius of the Moon is only about a quarter that of Earth, the lunar crust has a significantly greater average thickness. This thick crust formed almost immediately after formation of the Moon. Magmatism continued after the period of intense meteorite impacts ended about 3.

Chapter 5 : What is the Earth's Mantle Made Of? - Universe Today

The mantle is a thick layer of hot, mostly plastic rock that surrounds the core; atop the mantle is the thin shell of the earth's crust. On geologic time scales, the mantle behaves like a viscous liquid, with solid elements sinking and rising through its depths.

Chapter 6 : Fun Earth's Crust Facts for Kids

The continental crust of Mars is so iron-rich that, over billions of years, surface rocks actually rust when exposed to the meager oxygen in the planet's atmosphere. The result is a rust-coated planet that appears red, even from Earth.

Chapter 7 : Mantle Convection and Plate Tectonics (article) | Khan Academy

Ingredients. 1/3 cup butter, melted 1 cup all-purpose flour 1 cup sugar 1 tsp. baking powder 1/2 cup milk 2 cups berries 1/2 cup sugar For a low-fat crust, substitutte 1/2 cup applesauce for the butter.

Chapter 8 : Icelandâ€™s Volcanoes | Travel | Smithsonian

Mantle convection is the slow creeping motion of Earth's solid silicate mantle caused by convection currents carrying heat from the interior of the Earth to the surface. It is because the mantle can convect that the tectonic plates are able to move around the Earth's surface.

Chapter 9 : Mantle | calendrierdelascience.com

Its called Creeping Crust because the CRUST WILL RISE TO THE TOP AND CREEP OVER THE FRUIT. My family loves cobblers and this recipes adapts to any fruit and is the best Ive made or eatten. Serve warm or cold and dont forget the ice cream.