Post Prelims A Levels Preparation
Daily Essays By Kevin

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Why is the knowledge of plate tectonics important in understanding the distribution of earthquakes and volcanoes?

The knowledge of plate tectonics provides insights into the mechanisms driving the activities under the crust and the effects of these activities on the surface of the earth. It thus helps us understand the formation of volcanoes and the occurrence of earthquakes all around the globe. Knowing the interaction of the plates that covers the entire surface of earth gives us an explanation of the distribution of these tectonic activities on earth and in turn helps us understand the distribution of earthquakes and volcanoes.

To begin, knowledge of plate tectonics gives us the explanation for formation of volcanoes and occurrence earthquakes. Volcanoes are result of rising magma from beneath the surface of the earth that is released on the surface of the earth's crust. As such, plate convergence and divergence, as well as hotspot activities can result in volcanoes. On the other hand, earthquakes are results of relief of stress that has been accumulated between the margins of two plates, or when there's violent volcanic activities that sends out seismic waves in the ground. Shallow focus quakes thus occurs along transform faults where plates are moving in different direction relative to each other; deep focus quakes occurs along convergent plate boundaries where subduction occurs.

The majority of all volcanoes on earth are distributed along major convergent and divergent plate boundaries. The Pacific Ring of Fire, which connects the convergent margins between Pacific Plate and a couple of the other plates, happens to be where most of earth's volcanoes are distributed. This is explained by the activity subduction activities occurring along these plate margins. These subduction volcanoes are mainly stratovolcanoes and produce acidic lava. The shield volcanoes that produce basaltic lava, on the other hand, are distributed along the main divergent plate boundary like along the Mid-Atlantic Ridge, which connects the North America-Eurasia divergent boundary with the South America-African divergent boundary. Hotspot volcanoes are distributed within plates, like at the Hawaiian Islands, in the middle of the Pacific plate.

Earthquake activities are distributed in similar locations as the stratovolcanoes in the Pacific Ring of Fire, especially the deep focus quakes as these areas are where subduction produces the stress between the plates that are occasionally released. On the other hand, at divergent boundaries, the tensional forces between plates rarely cause any stress build up. However, the transform faults that are results of differential rates of divergence would accumulate strain that is released through shallow focus quakes. At other conservative plate boundaries, shallow focus quakes are also common, such as along the San Andreas Fault between the Pacific Plate and the North American plate.

In conclusion, the knowledge of plate tectonics helps explain the formation of volcanoes and occurrence of earthquakes thus allowing us to understand the distribution of these tectonic features based on the knowledge of plate location and the type of boundaries between the plates.

To what extent is it possible to predict the earthquakes and volcanic eruptions and to limit their hazardous effects?

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Earthquakes and volcano eruptions are both release of build up pressure within the earth and are common geo-activities. As both are result of a combination of many natural factors and variables, prediction of these tectonic events are difficult and would require large amount of information. In a long term perspective, forecast of probabilities of these events are possible but prediction is restricted to very short periods, possibly seconds before the occurrence. In general, prediction of volcanic eruption has been more possible than the prediction of earthquakes.

On the other hand, limiting hazardous effect of volcanic eruptions is restricted to evacuation and planned development based on the predictions made. The scope for limiting hazardous effects of earthquakes is wider, with a range of engineering techniques to design quake proof structures that would reduce the damage caused by ground-shaking.

Prediction of earthquakes have been an endeavour of man since the ancient times when the Chinese first invented the quake detection device to alert man of coming earthquakes. Since then, prediction of earthquakes has become much more sophisticated with seismometers to detect any seismic activities beneath the ground and studies of paleoseismic activities. Unfortunately, even with geophysical studies of the fault strain, the data accumulated about quake events of different locations over the past centuries, geoscientist can only give a probabilistic forecast of a quake of a particular magnitude range. That does little to limit the hazardous effects that the earthquake have on the area in concern. Prediction is less possible for areas without much data or equipments for measuring the fault accumulated in strains.

As a compensation for the weak ability to predict earthquakes, man have been able to come up with many quake-proof features that can be designed on structures to be built in areas prone to earthquakes. Seismic joints allow different parts of a building to rock independently as the quakes strike so that the energy can be dissipated easily; base isolation involving the use of rubber pads to isolate the building foundation from the rest of the structure would prevent seismic waves from being transmitted to the structures above ground, minimizing the chance of building collapse. As it is not the ground-shaking but the collapse of debris that usually makes earthquakes hazardous, designs that produces structures resistant to collapse of damage from ground-shaking would have the effect of limiting the hazardous effects. Nonetheless, these options involve high costs and may not be viable to developing countries.

Prediction of volcano eruptions has been more successful because the volcanoes would produce more signs of potential eruption before the actual event. Volcanologist are able to make predictions through the close study of the volcanic gases emitted, the volcanic materials that are released by the vent, the tilt of the volcano, the acidity of the springs in the volcano, and the seismic activities. Prediction of the eruption of Mt. Pinatubo in the 1991 has been lauded as one of the most successful attempts at fore-telling the event.

Besides evacuating the residents around the volcano and modeling the eruptions in order to map the hazards that may be unleashed by the volcano, there are no engineering techniques that are able to reduce the negative effects the eruption may have on the area. Lava diversion have been attempted with varying success and not considered a reliable means of limiting the lava hazard of volcanic eruptions. The only means of limiting the hazardous effects is only to avoid the volcano by controlling developing and relocating people from the area.

In conclusion, it is possible to make forecast about earthquakes but these are often not useful in limiting the hazardous effects of these events, but engineering options are available to reduce the hazards. As for volcanic eruptions, scientist have better chance of predicting them but less options of limiting the hazardous effects, they can only map the hazards and develop evacuation plans to reduce the casualties of these eruptions.