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What is the practical use of studying the deep Earth?

Concerning the Earth sciences I notice people tend to regard the study of the climate and the soil as of immediate and topmost importance. Global warming and desertification are issues acknowledged by everyone as significant and worthy of study. Studying the deep ocean is a topic which is a bit more debatable, but most people see the potential uses of it regarding resources we might obtain and the knowledge we can gain about oceanic currents. But the deep Earth... sorry its nice to know about plates drifting around a bit but going any deeper seems quite pointless. We can't affect those processes, we don't have the tools to take a close look, and above all what use is it to us?

Quite a bit it turns out. We live in a world that is continuously in motion. Violent earthquakes, volcanic eruptions, landslides and giant tsunamis shock the world. Rivers flooding periodically, oceanic currents, droughts and rainy seasons affect our daily pattern of life. Slower processes as the growing and eroding of mountains, the formation of new ocean basins and the filling up of older ones with sediment shape the landscape we live in. Sketches of the Earths surface throughout geological history reveal that there are processes at work, which are continuously re-shaping the land. We are dependent on the Earth we live on, but we are threatened by it as well, it is only natural that we try to find out as much about it as possible.

We know that the Earth exists of different layers. The crust is the part of the Earth we see, we live on, we get our food and resources from and the part we think we know. This can roughly be divided up into the lithosphere, the solid part of the Earth and the asthenosphere. The lithosphere is not one homogeneous layer but divided up into many segments called tectonic plates floating on the asthenosphere. Geologists have been studying the crust for centuries and done many important discoveries, most of all that the factors important in the formation of the lithosphere are driven by deeper processes.

When we want to find natural resources such as oil or coal, the chance of finding them increases tenfold if we know about the geology of the Earth. Oil is often found in layers of rock that have been folded to arch up. This type of deformation is directly coupled to plate tectonics where two plates are pushed together. Finding water reservoirs in dry areas also makes use of what we know about the lithosphere and the tectonic conditions. Studying water flow paths we see that they are usually split up by mountains, again products of tectonic collision.

New research has also shown that in places where two plates drift apart, such as at the Mid-Atlantic ridge, minerals are brought close to the surface by magma flows. There we may be able to win gold and other valuable minerals. Iceland is an island on the ridge. What people there realised is that such a large source of magma so near the surface is an excellent source of geothermal energy. This is a sustainable source of energy that will become more important in the future, and Iceland is not the only place it can be found.

For more knowledge about these phenomena we need to go deeper, to the mantle. This is a huge zone of magma that is in continuous movement due to convection currents. These

probably drive the tectonic plate movement, but we know little of the exact process. We don't know what drives them or when they will change their course. The conditions here are so hot and pressures rise so high we can't easily make measurements or conduct experiments. As the equipment we have is limited, we use natural phenomena to take a closer look. When a large earthquake occurs it sends shocks both through the crust, which we feel, and through the mantle. As the mantle is of an entirely different structure from the crust waves behave differently and scientists draw conclusions about the conditions in the mantle based on this.

Why study the forces deep down in the Earth if we can't influence them? It is important to understand the motions of the Earth in order to understand what can go wrong. Humans have lived on this Earth a relatively short time and as the population grows we settle in more dangerous areas.

We see countries like Bangladesh and the Netherlands, which are densely populated and located in a very low lying area. Tectonic movement is not only in a lateral direction, it is also vertical, movement of the land up and down. If we can predict the motion of the land we see the necessity of investing in coastal protection to prevent severe floods from ruining the lives of millions of people. We already know there is a danger but we need to asses how large it is in order to decide how we are going to handle it. If we know the land will subside at a rate of 5 cm per decade we know what type of defences we have to build to ensure that future generations also benefit from our efforts.

What we also know is that earthquakes and volcanoes are directly linked to tectonic movements. The Ring of Fire around the Pacific Ocean shows that where tectonic plates sink back into the asthenosphere they melt partially and cause volcanism and earthquakes. This poses danger to the people living nearby. Imagine we were able to measure how quickly plates were moving exactly. We might be able to predict earthquakes and volcanoes accurately. Accurate predictions could save millions of dollars in damages, not to mention millions of lives.

The world has faced some huge eruptions and earthquakes that were recorded in written history. But geo-hazards have a frequency of occurring that is related to their magnitude. It is quite likely that we have never witnessed the full extent of what an earthquake or a volcano can do, simply because it hasn't occurred yet. Research has shown we live in a relatively quiet period of the Earths history, but these dangers are real. If we knew more about the deep Earth, maybe we would be able to see large scale events coming, we would not be caught by surprise.

We can also link volcanism directly back to the Earth's climate. The most discussed greenhouse gas at the moment is CO_2 this is emitted on large scale by factories around the world. However, a single volcanic eruption can emit much more CO_2 than we could. There is much CO_2 dissolved in magma which all comes free at the moment an eruption takes place. Studying this and looking at significant outbursts in the past can give a clue as to how the climate responded to high CO_2 levels before.

Another factor that influences the climate is the topography of the land. The fact that the Sahara is a desert is due to the movement of the tectonic plates. The locations of mountain chains and oceans affect the annual rainfall in areas around the world. Currently the highest mountain range, the Himalayas is still growing due to the tectonic pressures. The river Rhine

in Europe has been and still is stealing away water from the Danube due to underground water flows.

When we look even deeper we reach the Earth's core. This exists of an outer core which we believe to be liquid and of an iron nickel alloy. The inner core is made up of solid iron and nickel. The outer core flows, creating a magnetic field around the Earth. This field will reflect electromagnetic rays from the sun emitted in solar flares. Without this shield the Earth would not be inhabitable to life as we know it. One moderate flare would immediately kill anyone in its path. The Earths magnetic field has been known to switch directions from time to time. Of course this is on a much longer time span than the generations we tend to think in. Yet currently scientist measure the magnetic field weakening on certain places on earth indicating that the process is still active. Still, we have no clue how or why this happens. Even weakening of the field has implications on many of the navigational devices we use in worldwide transport.

I hope that once people realise that when they look around they see the products of the deep Earths workings they want to know more in order to understand. We are completely dependent on our planet for everything, and realising there is so much we don't know yet is scary and inspiring at the same time. Studying the deep Earth is difficult but exciting, and ultimately doubtlessly very rewarding.