Internal Affairs Essay, Research Paper

Internal Structure of the Earth

What is the evidence for our knowledge of the internal structure of the Earth?

As we enter the twenty first century we are beginning to learn more and more about the composition of the Earth. Early predictions have thrown up some rather strange and peculiar thoughts as to what is making up our Earth, but now day’s scientists can be confident that the Earth is made up of what they think. As from experiments and other sources of information a picture to what is really down there is becoming much clearer.

So how do these scientists know that the Earth’s sections are made up of different compositions, and how do we know that the physical state of each layer is what it is?

The outermost layer of the Earth is the crust; this is what we stand on and covers the earth entirely. It is made up of many different rocks and minerals, we know that the composition of the Earth’s crust is generally the same due to the mines and boreholes that humans have made down into it. Mines that have been dug go down and still bring up valuable minerals that can be found just as close to the Earth’s surface. The deepest goes down around 3km into the earth, and the temperature is 70?XC, the only way for miners to work is because of the air conditioning, and still the type of rock looks the same all around. Also boreholes that have been drilled as far as half way into the Earth’s crust bring up rocks that look very similar to the ones on the surface. So scientists can safely say that the Earth has a crust which is very similar in composition all the way down until the mantle is reached.

When earthquakes happen they produce two types of waves P-waves and S-waves. Primary waves (p-waves) are the fastest waves; they travel away from a seismic event. Primary waves are longitudinal; they can travel through solids, liquids and gases. The secondary waves (s-waves) travel slower than the primary waves, and are traverse waves. This type of wave can only travel through solids. Measuring these waves is called seismology.

Scientists have known for a long time that the lava, which comes out from volcanoes when they erupt, was from the mantle. The asthenosphere is the probable source of much basaltic magma, this is because the velocity in S-waves is slowed down and partially absorbed in the asthenosphere. This gives the characteristics that the waves are passing through a solid, which the mantle is, but that contains a small amount of liquid. Also when the volcano erupt occasionally they shoot out solid nodules that have come from the solid rock in the mantle, the so-called plumbing of the mantle. These rocks have been broken of and carried out with the flow of the lava, this type of rock is called peridotite and is what mostly makes up the mantle. It is a fairly recent discovery to prove that the mantle of the earth is not the only part of the interior. Seismology is a new discovery this century that enables observations of natural ground vibration signals, basically the study of earthquakes. It can also be the study of artificially generated seismic signals.

Scientists then started to record these signals from earthquakes using seismographs, which are set in stations around the world to record the signals. In all some 125 stations exist around the world. They noticed that the P and S-waves did not travel in a straight line through the Earth, they came to the presumption that the Earth’s mantle was made up of many different materials. This caused the P and S-waves to travel at different speeds, because of the way the materials conduct the waves at different velocities. The waves also bent as they went from layer to layer, this caused their path through the interior of the earth to be curved.

This was then put into practice, so after an earthquake happened in a country the P and S-waves were sent out. Further around the globe the waves were expected to be received after a couple of minutes. Which they would, first the P-waves came followed by the S-waves, with an interval time in the middle. This time could then be scaled up to give the results of what they though would be the times for the P and then the S-waves to arrive at other destinations. This theory was correct, further away from the point of the epicenter; first the P-waves arrived followed by the S-waves a few minutes later. So then they thought that this would be the case for all over the globe, but they found out something else. They tried to predict the time they expected the waves to reach a destination on exactly on the other side of the globe, so they scaled up the time interval between the two waves arriving. First the P-wave arrived, on time as they expected but the S-wave didn’t, this was because the P-waves can travel through any physical state.

However S-waves can only travel through solids which is why they can pass through the mantle, so a change of physical state must happen in the middle of the mantle somewhere. The area where the S-waves enter and do not come back out is called the shadow zone. The P-waves also have a shadow zone. This would be from about 105?X to

142?X marked from the Focus of the earthquake. This is because when the P-waves enter the core they are bent downwards, they are then bent down again when they leave the core-mantle boundary. So no waves can emerge at the surface before 142?X.

From these results scientists are convinced that inside the mantle there is a molten core that must be blocking out the S-waves.

So scientists have very good evidence to prove what they believe to be inside of the mantle. They even have their ways to prove what they believe the core to be made up of, they think there are two layers, an inner core surrounded by the outer core. The outer core is believed to be made up of liquid iron and the actual center of the core is made of solid iron.

They have numerous reasons to back up this theory.

Scientists can work out how big the mass of the earth is, not by trying to weigh it because that is merely impossible. Instead they used the gravity on the earth to help them. We know the velocity at which objects fall to the earth, so from this scientists were able to work out the mass of the earth. So they found the total mass of the earth, and compared that to a mass made up of just the crust and the mantle. They could get this mass reading because they know the density of the crust and the mantle. However even after working this mass out the total amount was well short, compared with the mass they found from using the velocity at which objects fall to the earth. So they were convinced by these results that the mantle was not the only thing down there, they put the lack of mass to believing that something heavier and denser was in the middle.

When the earth formed it originally condensed, by gravitational attraction of cosmic dust and gas. The continuing contraction of these materials caused them to heat, as did some of the radioactivity of some of the heavier elements. As this progressed the earth became very hot and it began to melt. This caused the different layers to form in the earth, because all the lighter materials moved up to the surface to produce the crust. So the heavier materials like the metals iron and nickel sank to form the core, the materials in the mantle were made form the silicates that didn’t sink or float.

When meteorites reach the surface of our planet before they are entirely consumed, they provide us with valuable information. Meteorites are believed to be fragments from other planets, formed some 4.6 billion years ago. Around the same time as the earth was been formed. These meteorites are mostly made up of iron; this is what excites scientists. As they believe that this is proof that the middle core of our earth is made from solid iron. Thinking that meteorites are part of planets that have broken up and sent fragments flying out into space.

So they know that the inner core is solid iron but why when the outer core is a liquid iron. Well as the depth increases in the earth then so does the pressure. So scientists put the solid middle down the fact that the pressure becomes too much for the liquid iron, so the pressure solidifies the core.

Another point of evidence is the earth’s magnetic field, again suggesting an iron core, because iron is a metal that can be magnetized. The magnetic field is thought to be in the liquid outer core, because of the readily movement, and iron been a good conductor. This is what may be required for a dynamo with the capacity to generate enough current to produce the earth’s magnetic field. The liquid iron is thought be stirred in a motion by heat from the core. This action is thought to produce an electric current and therefore the magnetic field. This is another explanation as to the outer core been liquid, because if it wasn’t then where would the magnetic field come from. As permanent magnetism cannot be kept with temperatures exceeding 500?XC, however the outer core may well produce electric currents because of the free movement. The inner core would not be able to do this, as it is a solid.

Bibliography

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