How do scientists know what is in the core of the earth?

Well, we have a pretty good idea from a variety of indirect measurements and reasonings:

First, we know the overall density and mass of the Earth based on measurements of how the Earth perturbs the orbits of other planets and the moon.

Second, we know the overall density of the various layers of the Earth based upon the way in which seismic pressure waves (compressional waves created by earthquakes) move through the earth to arrive at locations remote from the earthquake source.

Third, by examining a second type of seismic wave (a shear wave, that is equivalnet in motion to a back and forth rubbing of one's hands together) we know that the outer part of the core is liquid, even though it is at immense pressure from being underneath so much rock. Shear waves can't travel through liquids.

Forth, we know the overall composition of the Earth by examining the bulk chemical composition of the Sun (by examining its light spectrum) and by analyzing a class of meteorites known as Chondrites (which have similar composition to the Sun and are believed to be similar to the material from which the Earth accreted).

Fifth, we know the composition of the Earth's crust and its mantle, by examining samples of them. For the lower mantle, we use experiments of the effect of pressure on upper (shallow) mantle minerals to predict the mineralogy of the lower reaches of the mantle. We then pass seismic waves through it in the lab to see if our experimental rocks match the observations.

Six, now that we know the size, mass and composition of the whole Earth, its crust, and its mantle, we can construct a balance sheet of materials and see which chemical elements aren't in the crust (including atmosphere and hydrosphere) or mantle that we know should be on the Earth. These must be in the core.

Seven, to aid us in our assessment, we recall that we need metallic elements in high concentration somewhere in the interior of the Earth to generate our magnetic field. Also, this metal must be able to be in the liquid state even at very high pressures.

Adding all this up, we find the core is predominantly Iron metal (Fe). We find it has a significant amount of the element Nickel (Ni, about 4%) and a light element to make it less dense (about 10% by mass). This light element is either mostly oxygen or sulfur, with the arguments for oxygen (too detailed to go into here) being more believable in general.

We can look at the composition of iron meteorites as well, which are remnants of small planetary bodies from early in our solar-system's history that segregated small cores. The composition of these metal alloys matches closely what we predict the composition of our core is using the evidence discussed above.

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