

Gold, Pollution, and Farmland--Common Q/A

Earth Science Essentials
by Russ Colson

I don't get the idea of mass balance. To get a new composition, don't we have to make new elements?

Chemical reactions don't change the elements, they only rearrange them into different combinations. In geochemical differentiation, a batch of elements gets split into two parts by chemical and physical processes. The two parts will have different compositions, but all of the elements that were originally present are still there, just combined differently.

Suppose that you have a jar of marbles, and the marbles are half red and half blue. If you remove half of the red marbles and put them in a different jar, you now have two batches of marbles, one that is 100% red marbles and the other that is 75% blue marbles and 25% red. But all of the marbles that you originally had are still present in the two jars.

It is possible that not all the elements will stay in one place. For example, some might remain behind when magma from a partial melting event in the mantle rises to the surface. Some elements from the erupted magma might go into a gas phase and blow away during the eruption. Some might go into the water, giving it a cool turquoise color. Some might go into altering the rock hydrothermally (notice the red colors in the picture).



Sometimes we do get new elements, by radioactive decay, as we talked about previously.

Santa Ana volcanic caldera El Salvador. Courtesy of Fenner Colson

In that case, an unstable nucleus decays to form a different element, like Rb-87 decays to form Sr-87. These are nuclear reactions, or reactions that take place in the nucleus of an atom, different from chemical reactions.

Is it possible that there are elements on other planets that we've never discovered on Earth?

Elements are defined by the number of protons in the nucleus of an atom. Hydrogen has 1 proton, Helium has 2 protons, and so on all the way up to Uranium, the heaviest naturally occurring element with 92 protons. Since there aren't any missing atoms in between, there isn't any chance of some other element existing on another planet. Other elements with higher numbers of protons have been manufactured in the lab, but these elements are so highly radioactive that they can't exist for geologically significant lengths of time. It's possible that there might be very heavy elements with many more protons than we have been able to manufacture in the lab that are stable on geologically-meaningful time frames—but that remains to be shown.

There are some elements that are very rare on Earth because all of their isotopes are radioactive and so they decay into a different element very quickly. These include the elements Technetium and Promethium. Scientists recognized that these elements were 'missing' and eventually discovered them in the byproducts of fission reactors.

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