Researchers discover helium billions of years old being released in Yellowstone

February 20 2014, by Bob Yirka

Steam plumes rise above thermal features along the Firehole River, Yellowstone National Park. Credit: Ken McGee, U.S. Geological Survey

(Phys.org) —A team of researchers with the U.S. Geological Survey has found that a large amount of ancient helium is constantly being released in Yellowstone National Park—the result, they suggest in their paper published in the journal *Nature*, of a magma hot spot releasing previously trapped gasses.

In surveying the gasses that emanate from various parts of the famous park, the researchers discovered far higher amounts of the helium-4 isotope than was expected—approximately 60 tons every year. Helium isotope emanations generally come in two varieties, helium-3 and helium-4. Helium 3 has been found by prior research to come from deep within the Earth, whereas Helium-4 is more often found in the crust—the result of decaying radioactive (uranium and thorium) elements. Helium-3 has been measured at the park before—it gets pushed up to the surface due to ancient volcanic activity. Finding Helium-4 emanating from cracks and fissures in above-normal amounts indicated that the helium was coming from the crust. But why so much?

To answer that question, the researchers looked at the long geological history of the region—approximately two million years ago, volcanic activity began in the area. Prior to that, they say, the area was relatively quiet, for perhaps as long as a couple of billion years. During that time it appears that helium was building up in the crust (because there was no groundwater or crust movement), but not so much to the point that it created enough pressure to push its way to the surface. That didn't happen until the area became volcanic—hot magma beneath the trapped helium pushed it upwards, eventually squeezing it through cracks, steam vents and geysers at the surface. And that's why it's happening right now—it's been going on all this time and has just now been noticed.

Gas passes through a hot spring at the Shoshone Geyser Basin, Yellowstone National Park. A funnel is used to transfer the gas to an evacuated sampling bottle. Credit: J. Lowenstern, U.S. Geological Survey

Because the helium is so old, the researchers believe it might hold secrets about the maturation of our planet—it also provides another example of gasses or liquids being held in the Earths' crust for billions of years, which some suggest might mean that its possible some forms of subsurface life exist that have never been seen.

Automated accumulation chambers permit estimation of the diffuse flux of CO2 through soils at the Solfatara Plateau Thermal Area, Yellowstone National Park. Credit: J. Lowenstern, U.S. Geological Survey

More information: Prodigious degassing of a billion years of accumulated radiogenic helium at Yellowstone, *Nature* 506, 355–358 (20 February 2014) DOI: 10.1038/nature12992

Abstract
Helium is used as a critical tracer throughout the Earth sciences, where its relatively simple isotopic systematics is used to trace degassing from the mantle, to date groundwater and to time the rise of continents1. The hydrothermal system at Yellowstone National Park is famous for its high helium-3/helium-4 isotope ratio, commonly cited as evidence for a deep mantle source for the Yellowstone hotspot2. However, much of the helium emitted from this region is actually radiogenic helium-4

produced within the crust by α-decay of uranium and thorium. Here we show, by combining gas emission rates with chemistry and isotopic analyses, that crustal helium-4 emission rates from Yellowstone exceed (by orders of magnitude) any conceivable rate of generation within the crust. It seems that helium has accumulated for (at least) many hundreds of millions of years in Archaean (more than 2.5 billion years old) cratonic rocks beneath Yellowstone, only to be liberated over the past two million years by intense crustal metamorphism induced by the Yellowstone hotspot. Our results demonstrate the extremes in variability of crustal helium efflux on geologic timescales and imply crustal-scale open-system behaviour of helium in tectonically and magmatically active regions.

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