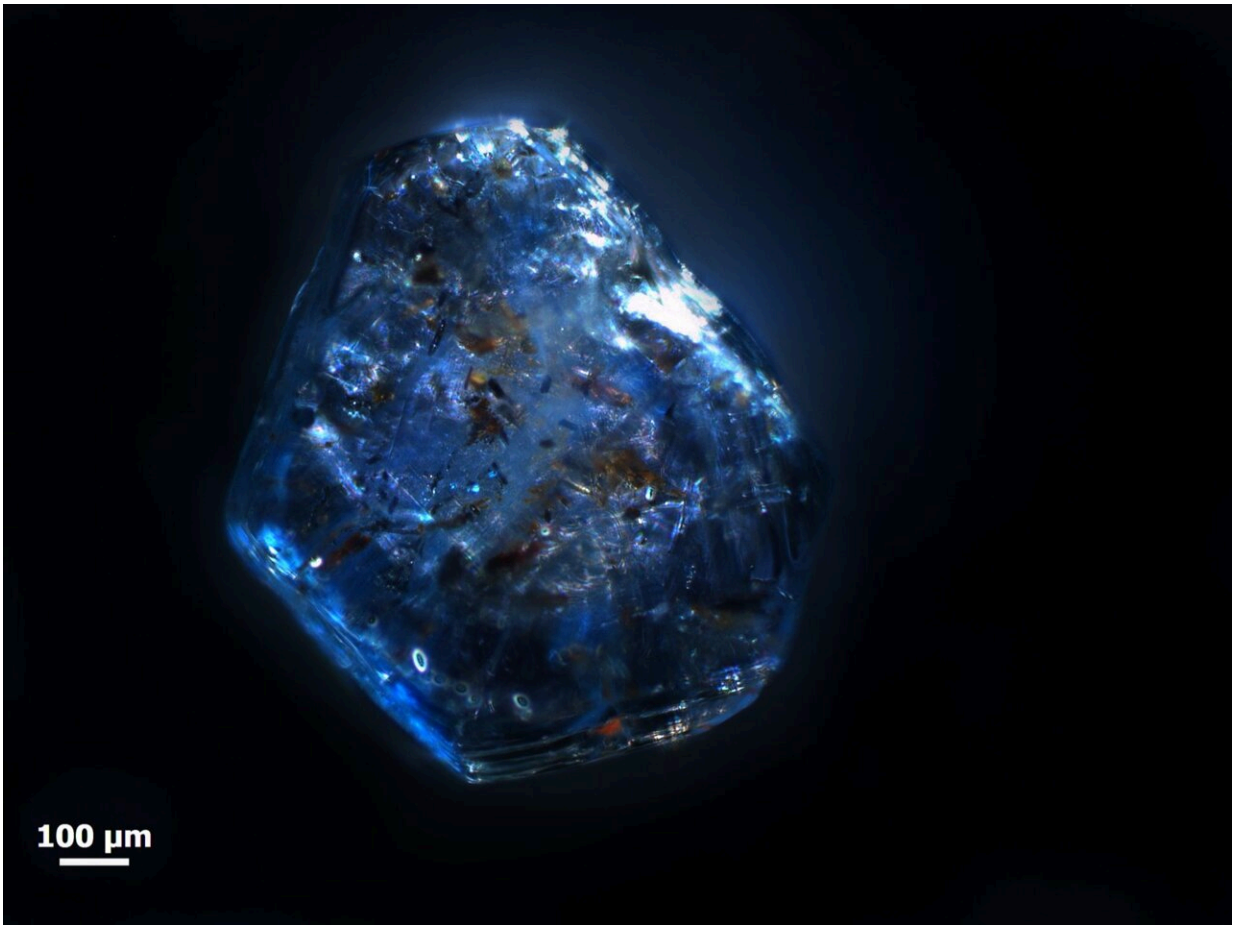
A blue miracle in the Eifel: How sapphires formed in volcanoes

July 29 2024



Credit: A sapphire from sediment in the Kyll, a river in the western Eifel. The crystal measures approximately 0.9 mm in diameter. Credit: Sebastian Schmidt

Researchers at Heidelberg University are studying the formation of this characteristically blue-colored crystal in volcanic melts

Sapphires are among the most precious gems, yet they consist solely of chemically "contaminated" aluminum oxide, or corundum. Worldwide, these characteristically blue-colored crystals are mainly found in association with silicon-poor volcanic rocks. This connection is widely assumed to result from sapphires originating in deep crustal rocks and accidentally ending up on the Earth's surface as magma ascended.

Through geochemical analyses, geoscientists at Heidelberg University have shown that the millimeter-sized sapphire grains found in the Eifel (Germany) formed in association with volcanism. The work is published in the journal *Contributions to Mineralogy and Petrology*.

The Eifel is a volcanic region in the center of Europe where magma from the Earth's mantle has been penetrating the overlying crust for nearly 700,000 years. The melts are poor in silicon dioxide but rich in sodium and potassium. Magmas similar in composition worldwide are known for their abundance of sapphire. Why this extremely rare variant of corundum is frequently found in this type of volcanic deposit has been a mystery until now.

"One explanation is that sapphire in the Earth's crust originates from previously clayey sediments at very high temperatures and pressure and the ascending magmas simply form the elevator to the surface for the crystals," explains Prof. Dr. Axel Schmitt, a researcher at Curtin University in Perth (Australia) who is investigating isotope geology and petrology as an honorary professor at the Institute of Earth Sciences at Heidelberg University—his former home institution.

To test this assumption, the researchers examined a total of 223 sapphires from the Eifel. They found a portion of these millimeter-sized

crystals in rock samples collected from volcanic deposits in the numerous quarries in the region. Most of the sapphires, however, come from river sediments.

"Like gold, sapphire is very weathering-resistant compared to other minerals. Over protracted time periods, the grains are washed out of the rock and deposited in rivers. Because of their high density, they are easy to separate from lighter sediment components using a gold pan," explains Sebastian Schmidt, who conducted the studies as part of his master's degree at Heidelberg University.

The researchers determined the age of the sapphires from the Eifel using the uranium-lead method on mineral inclusions in the sapphire using a secondary ion mass spectrometer that could also identify the composition of oxygen isotopes. The different relative abundances of the light isotope O-16 and the heavy isotope O-18 provide information on the origin of the crystals like a fingerprint. Deep crustal rocks have more O-18 than melts from the Earth's mantle.

As the age determinations show, the sapphires in the Eifel formed at the same time as the volcanism. In part, they inherited the isotopic signature of the mantle melts, which were contaminated by heated and partially melted crustal rock at a depth of about five to seven kilometers. Other sapphires originated in contact with the subterranean melts, whereby melts permeated the adjacent rock and thus triggered sapphire formation.

"In the Eifel, both magmatic and metamorphic processes, in which temperature changed the original rock, played a role in the crystallization of sapphire," states Schmidt.

More information: Sebastian Schmidt et al, Petrologically controlled oxygen isotopic classification of cogenetic magmatic and metamorphic

sapphire from Quaternary volcanic fields in the Eifel, Germany, *Contributions to Mineralogy and Petrology* (2024). DOI: 10.1007/s00410-024-02136-x

Provided by Heidelberg University