

CALCIUM SILICATE INCLUSION IN DIAMOND NAMED AFTER GERHARD BREY



Gerhard Brey

Inclusion-bearing diamonds are messengers from the Earth's deep interior. Although economically less valuable they are the real gems for researchers. They deliver information from the lithosphere down to the transition zone and lower mantle and reveal processes occurring at depths of at least 800 km. One of the most common minerals from the ultra-deep has now been named "breyite" ($\text{Ca}_3\text{Si}_3\text{O}_9$) by the Commission on New Minerals, Nomenclature and Classification of the International Mineralogical Association (IMA) in honour of the German mineralogist Gerhard Brey, who is from the Goethe-University of Frankfurt (Germany).

Gerhard Brey and his research group started to focus on the study of mineral inclusions in the late 1990s. This was when Thomas Stachel (now Diamond Chair in Edmonton, Canada) and Jeff Harris (University of Glasgow, UK) joined Brey's group in Frankfurt. With them, diamonds containing ultra-deep inclusions from the new African locality of Kankan (Guinea) came to Frankfurt. At this time, it was firmly established by geophysical and high-pressure experimental work that the Earth's lower mantle (at a depth of 660–2,900 km) consists almost exclusively of just three minerals: Mg-silicate perovskite (now called bridgmanite), ferropericlae, and a Ca-silicate with a perovskite structure. When diamonds form at these depths, it was predicted that they trap these minerals. However, evidence from nature was lacking until ferropericlae and bridgmanite were reported in the late 1980s as inclusions in diamonds from a few localities worldwide, though mainly from Juina (Brazil).

The diamonds studied by the group in Frankfurt in the late 1990s contained optically identifiable ferropericlae inclusions, along with many colourless unknown phases. Analysis by X-ray diffraction (with Werner Joswig) and microchemical analyses revealed a new Ca-rich silicate inclusion suite with walstromite-structured CaSiO_3 (now the newly named mineral breyite), titanite-structured CaSi_2O_5 and larnite ($\beta\text{-Ca}_2\text{SiO}_4$). These were interpreted as successive retrograde phase transformations of original Ca-silicate perovskite during transport towards the Earth's surface. The reasoning was such that "breyite" was found occasionally together with bridgmanite and ferropericlae in a single diamond and must, therefore, have originally been perovskite-structured. Other diamonds contain touching pairs of larnite and titanite-structured CaSi_2O_5 as a result of the disproportionation of Ca-silicate-perovskite during upward transport.

At Juina (Brazil), the Ca-phases are overabundant compared to the lower mantle phases of ferropericlae and bridgmanite, and at this locality further Ca-rich silicate phases were found. Frank Brenker (Goethe-University, Frankfurt) even discovered calcite as inclusions in these diamonds. It means that other geochemical reservoirs besides the peridotitic lower mantle must exist from which these phases crystallize. These geochemical reservoirs may be created by subduction processes acting on a mélange of altered basalts, ocean sediments and serpentinites. It may well be that breyite also exists in such zones at depths greater than 100 km. Breyite and diamond may directly precipitate together from the reaction $\text{CaCO}_3 + \text{SiO}_2 \rightarrow \text{CaSiO}_3 + \text{C} + \text{O}_2$, which is a well-known metamorphic reaction coupled with a redox process.

"Having a mineral named after you is a very special honour and pays tribute to the life work of a scientist in a special and lasting way," states Brey's colleague Frank Brenker. "Especially, when we're talking about such an important Earth mineral, Gerhard Brey's name is now forever carved in stone, so to say."

Gerhard Brey, who retired in 2014, is considered a pioneer in high-pressure experimental petrology. He achieved world recognition through the development and calibration of geothermobarometers for rocks in



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the Earth's mantle. These thermobarometers are not only crucial aids in researching the Earth's interior, they are also very popular in the search for new diamond deposits. Whereas it used to be necessary to process tons of rocks to determine whether a deposit really contained diamonds, now only a few grains of mineral are needed.

In addition to thermobarometric calculations, Gerhard Brey is interested in the solubility of volatiles in melts, their influence on the formation of magmas in the mantle and their role in metasomatic processes. He and his group were also the first to determine absolute ages of metasomatism in the sub-cratonic mantle and also to determine its cooling rate from radiogenic isotope systems.

Brey has received numerous distinctions, including an honorary doctorate from the Russian Academy of Sciences and the highest scientific award of the German Mineralogical Society, the Abraham Gottlob Werner Medal in Silver.

Heidi Höfer, Frankfurt

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K4 Solid-State NMR Spectroscopy (Anwendungen der Festkörper-NMR-Spektroskopie in der mineralogischen und geowissenschaftlichen Forschung), Institute for Geology, Mineralogy and Geophysics, Ruhr University Bochum (Germany), Dr. Michael Fechtelkord, 11–14 June 2019 (michael.fechteltkord@rub.de)

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