American Mineralogist, Volume 107, pages 778–780, 2022

New Mineral Names: High-Pressure and Precious Minerals

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Abstract

In this issue of New Mineral Names, a thematic approach is used to help provide context for advances and discoveries in mineralogy. Recovered high-pressure minerals are not commonplace, rare platinum group elements tend to be recovered from important ore bodies, and then there are the minerals/collections that are culturally important and significant to the history of science. Here we investigate the newly discovered high-pressure minerals and highly precious minerals: davemaoite, kaitianite, elgoresyite, oberthüite, torryweiserite, palladothallite, fleetite, tamuraite, marathonite, palladogermanite, and kernowite.

Davemaoite

Davemaoite (Tschauner et al. 2021), $CaSiO_3$, was named in honor of Dave (Ho-kwang) Mao for his eminent contributions to experimental geophysics and his leadership in high-pressure mineral physics. Much of his work had a direct impact on understanding the deep Earth chemical and physical processes that furthered research of Earth's evolutionary history.

Davemaoite is a perovskite mineral that was found as an inclusion in an octahedral diamond in one of the world's largest diamond mines, Orapa Mine in Botswana. The diamond was later cut and polished to bring the inclusions closer to the surface for experimental analysis. Davemaoite occurs with carbonaceous α-iron and wüstite, and other inclusions in the diamond include ilmenite, iron, and ice-VII. Remnant pressure in the diamond (estimated to between 7 and 9 GPa) was attributed to the mineral's survival at the Earth's surface.

The preservation of davemaoite in a diamond is the first known high-pressure silicate mineral recovered from the lower mantle. Up to now, no one has observed $CaSiO_3$-perovskite from the lower mantle because it is essentially thought to be unquenchable (Fei 2021). Synthetic $CaSiO_3$-perovskite has been shown to lose its crystal structure upon decompression from high pressure (Mao et al. 1989). The only other high-pressure silicate mineral found from lower-mantle pressures to date was bridgmanite ($MgSiO_3$-perovskite) but was found inside a meteorite.

Davemaoite crystallizes in space group $Pm\bar{3}m$ with a = 3.591(2) Å and a calculated density of 4.20 g/cm^3. The mineral was approved in 2020 by the Commission on New Minerals, Nomenclature and Classification (IMA 2020-012a). The two holotype specimen was deposited in the collections of the Natural History Museum of Los Angeles County, California, U.S.A. (catalog number: 74541).

Kaitianite

Kaitianite (Ma and Beckett 2021), $Ti^{3+}_2Ti^{4+}O_5$ was derived from two Chinese words, Kai and Tian, meaning the heaven and the sky. These words are from ancient Chinese mythology where the giant (named Pan Gu) created the world by separating the heaven and earth. Panguite (Ma et al. 2012) also is named from this mythological story.

Kaitianite was found as a 2 μm sized mineral grain in the Allende CV3 chondrite (USNM 35105) within a grain of tistarite (Ti_2O_3). Incredibly, there have been 19 new approved minerals found in this one meteorite since 2007. The authors describe the formation of kaitianite through the oxidation of tistarite.

Kaitianite crystallizes in space group $C2/c$ with a = 10.115 Å, b = 5.074 Å, c = 7.182 Å, β = 112°. The mineral was approved in 2020 by the Commission on New Minerals, Nomenclature and Classification (IMA 2017-078a) The holotype specimen of kaitianite in Allende section UNSM 3510-5 is in the collections of the Smithsonian Institution National Museum of Natural History, Washington, D.C., U.S.A.

Elgoresyite

Elgoresyite (Bindi et al. 2021), $(Mg,Fe)_5Si_2O_9$ in named in honor of Dr. Ahmed El Goresy, a prominent researcher focused on minerals of extraterrestrial material. He made many discoveries of shock-induced high-pressure phases in meteorites at terrestrial impact sites, and much of his work contributed to our understanding of cosmochemical processes in the early parts of our solar system.

Elgoresyite was found as a shock-induced melt vein of the Suizhou L6 chondrite meteorite and is a high-pressure mineral that may represent an intermediate phase at pressures characteristic for the existence of ringwoodite and bridgmanite. The authors suggest that it could have formed in the cores of early solar system planetoids and could be a representative mantle mineral of rocky bodies that had a higher Mg:Fe ratio than Earth or Mars.

Elgoresyite crystallizes in space group $C2/m$ with a = 9.397(2) Å, b = 2.763(1) Å, c = 11.088(3) Å, β = 94.25(2)°. The mineral was approved in 2020 by the Commission on New Minerals, Nomenclature and Classification (IMA 2020-086). The holotype material containing elgoresyite is deposited in the collections of the Museo di Storia Naturale, Università degli Studi di Firenze, Italy (catalog number: 3238/I).

Oberthürite and Torryweiserite

Two new rhodium minerals that were described together are oberthürite and torryweiserite (McDonald et al. 2021b). Oberthürite, $Rh_3(Ni,Fe)_{32}S_{32}$, is named in honor for Dr. Thomas Oberthür, a retired scientist from the German Geological Survey. He is a respected researcher on alluvial platinum-group minerals (PGM) most notably those found in deposits related to the Great Dyke and the Bushveld complex. Torryweiserite, $Rh_5Ni_{10}S_{16}$, is named in honor for Dr. Thorolf "Torry" W. Weiser, who is also a retired scientist from the German Geological Survey where he headed the electron microprobe laboratory. Dr. Weiser is also a well-known researcher on the PGM most notably those found in deposits related to the Great Dyke and the Bushveld complex.

These minerals were both found in the Marathon deposit, part of the

* All minerals have been approved by the IMA CNMMC. For a complete listing of all IMA-validated unnamed minerals and their codes, see http://cnmnc.main.jp/ (click on "IMA list of minerals").

0003-004X/22/0004–778$05.00/DOI: https://doi.org/10.2138/am-2022-NMN107411

Coldwell Complex in Ontario, Canada, an area known for platinum group elements and rare earth element minerals. Both minerals were identified in an enriched-ore, heavy-mineral concentrate, and later identified in thin section. Oberthürite and torryweiserite are topologically identical with pentlandite.

Oberthürite crystallizes in space group $F\overline{4}3m$ with a = 10.066(5) Å. The mineral was approved in 2017 by the Commission on New Minerals, Nomenclature and Classification (IMA 2017-072). Torryweiserite crystallizes in space group $R\overline{3}m$ with a = 7.060(1) Å and c = 34.271(7) Å. The mineral was approved in 2020 (IMA 2020-048). Portions of the holotype for each mineral (single-crystal X-ray mount) have been deposited in the collections of the Canadian Museum of Nature, oberthürite (catalog number: 87251) and torryweiserite (catalog number: 87181).

Palladothallite

Palladothallite (Grokhovskaya et al. 2021), Pd_3Tl, is named after its chemical composition. Palladothallite was found in while investigating a heavy-mineral concentrate made from drill core obtained from the Monchetundra layered intrusion, Kola Peninsula, Russia, and was preliminarily described as an unnamed Pd_3Tl phase in polished sections of sulfide-bearing orthopyroxenite.

Palladothallite does not have a structural analog to other minerals, but there was a material $TlPd_3H$ (Kurtzemann and Kohlmann 2010) that was synthesized in the course of a study investigating hydrogen absorption a from noble metal compounds. From the association of palladothallite with base metal sulfide mineral and PGM, palloaddothallite likely formed from post-magmatic or high-temperature hydrothermal conditions (below 600 °C) as estimated from its synthetic analog as $TlPd_3$ was made as a byproduct during their reaction (heated dry in air at 600 °C).

Palladothallite crystallizes in space group $I4/mmm$ with a = 4.10659(9) Å and c = 15.3028(4) Å. The mineral was approved in 2020 by the Commission on New Minerals, Nomenclature and Classification (IMA 2020-009a). The holotype (polished section 1818006-2017) is deposited in Natural History Museum, London, U.K. (catalog number: BM 2019,1).

Fleetite

Fleetite (Barkov et al. 2021a), $Cu_2RhIrSb_2$, is named in honor of Dr. Michael Edward Fleet, who was a professor of mineralogy in the Department of Earth Sciences at Western University (London, Ontario, Canada). Dr. Fleet had a wide range of mineralogical interests that include the study of platinum group minerals, thermodynamics, apatite minerals, sulfides, and the structure of silicate melts.

Fleetite occurs as a single small grain in contact with an Os-Ir(-Ru) alloy. The grain was found after examining hundreds of placer grains that were collected from the Miass Place Zone in the Miass River on the eastern side of the Ural Mountains in Russia. Fleetite likely formed at a late subsolidus stage of fluid-mediated transformations as a result of the buildup of S, As, and Sb in the fluid phase. The replacement reactions locally affected the primary Ru-Os-Ir and Pt-Fe alloys, which constitute the host minerals of these intergrown exotic phases.

Fleetite crystallizes in space group $Fd\overline{3}m$ with a = 11.6682(8) Å. The mineral was approved in 2018 by the Commission on New Minerals, Nomenclature and Classification (IMA 2018-073b). The holotype specimen is deposited at the State Museum of Geology of Central Siberia, Krasnoyarsk, Russia (catalog number: 1/41/11 00 2).

Tamuraite

Tamuraite (Barkov et al. 2021b), $Ir_5Fe_{10}S_{16}$, is named in honor of Dr. Nobumichi Tamura, a senior scientist at the Advanced Light Source, Lawrence Berkeley National Laboratory. He is an expert in synchrotron based micro-diffraction techniques and is also a widely respected scientific illustrator who recently depicted *Shonisaurus sikanniensis*, the largest ichthyosaur discovered to date.

The mineral was found in a placer along the River Ko, south of Krasnoyarsk, Russia, as part of a heavy-mineral fraction recovered from the river. Grains of tamuraite form part of roundish composite inclusions of sulfide minerals rich in platinum-group elements (PGE); the polymineralic inclusions are hosted by Os-Ir alloy grains. The authors stat that tamuraite formed at an advanced stage of crystallization in sulfur in droplets of a residual melt. These droplets were enriched in S, Fe, Ni, Cu, and Rh, and these elements were incompatible during the formation the Os-Ir alloy lode zones.

Tamuraite crystallizes in space group $R\overline{3}m$ with a = 7.073(1) Å and c = 34.277(8) Å. The mineral was approved in 2018 by the Commission on New Minerals, Nomenclature and Classification (IMA 2020-098). The holotype specimen of tamuraite is deposited at the Central Siberian Geological Museum, Sobolev Institute of Geology and Mineralogy, Novosibirsk, Russia (catalog number: III-102/2).

Marathonite and Palladogermanide

Two new palladium minerals were found together, marathonite ($Pd_{25}Ge_9$) and palladogermanide (Pd_2Ge) (McDonald et al. 2021a). Marathonite is named of the town of Marathon in Ontario, Canada, and palladogermanide is named after its chemical formula.

Both marathonite and palladogermanide were identified in an enriched-ore, heavy-mineral concentrate and in polished thin sections. Palladogermanide is named after the bulk chemical formal for that mineral. They were both found in the Marathon deposit, Coldwell Complex in Ontario, Canada. The Marathon Cu-PGE-Au deposit is sulfide host rock that was formed from during an emplacement of a >1 Ga gabbroic sill.

Marathonite crystallizes space group $P3$, with a = 7.391(1) Å, c = 10.477(2) Å. The mineral was approved in 2016 by the Commission on New Minerals, Nomenclature and Classification (IMA 2016-080). A portion of the holotype for marathonite (single-crystal X-ray mount) has been deposited in the collections of the Canadian Museum of Nature, Gatineau, Quebec, Canada (catalog number 87180). The structure of palladogermanide was inferred from a synthetic analog (Wopersnow and Schubert 1977) and is considered to be hexagonal with a = 6.712(1) Å and c = 3.408(1) Å and was approved in 2016 (MA 2016-086).

Kernowite

Kernowite (Rumsey et al. 2021), $Cu_2Fe(AsO_4)(OH)_4 \cdot 4(H_2O)$, is named after the world for Cornwall in the Cornish language (Kernow) and was found in a museum specimen from the Sir Arthur Russel Collection of the British Museum. This mineral may not have precious metals as constitute chemistry, but it is a precious museum specimen from a famed collector of natural history objects.

The specimen that kernowite was found in the museum drawers and was labeled as liroconite. It was selected in part because of an ongoing study in liroconite, however, it was determined to have too much iron to be liroconite as determined by energy-dispersive spectroscopy. Such old samples (dating back 215+ years ago) are difficult to determine the origin of, or who collected them. However, its provenance was estimated as being from Wheal Gorland, a mine in Cornwall, U.K., known for its copper arsenate minerals.

Kernowite crystallizes in space group $C2/c$, with a = 2.9243(4) Å, b = 7.5401(3) Å, c = 10.0271(3) Å, β = 91.267(3)°. The mineral was approved in 2020 by the Commission on New Minerals, Nomenclature and Classification (MA 2020-053). The holotype specimen remains in the collection Natural History Museum, London, U.K. (catalog number: BM1964, R8908).

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