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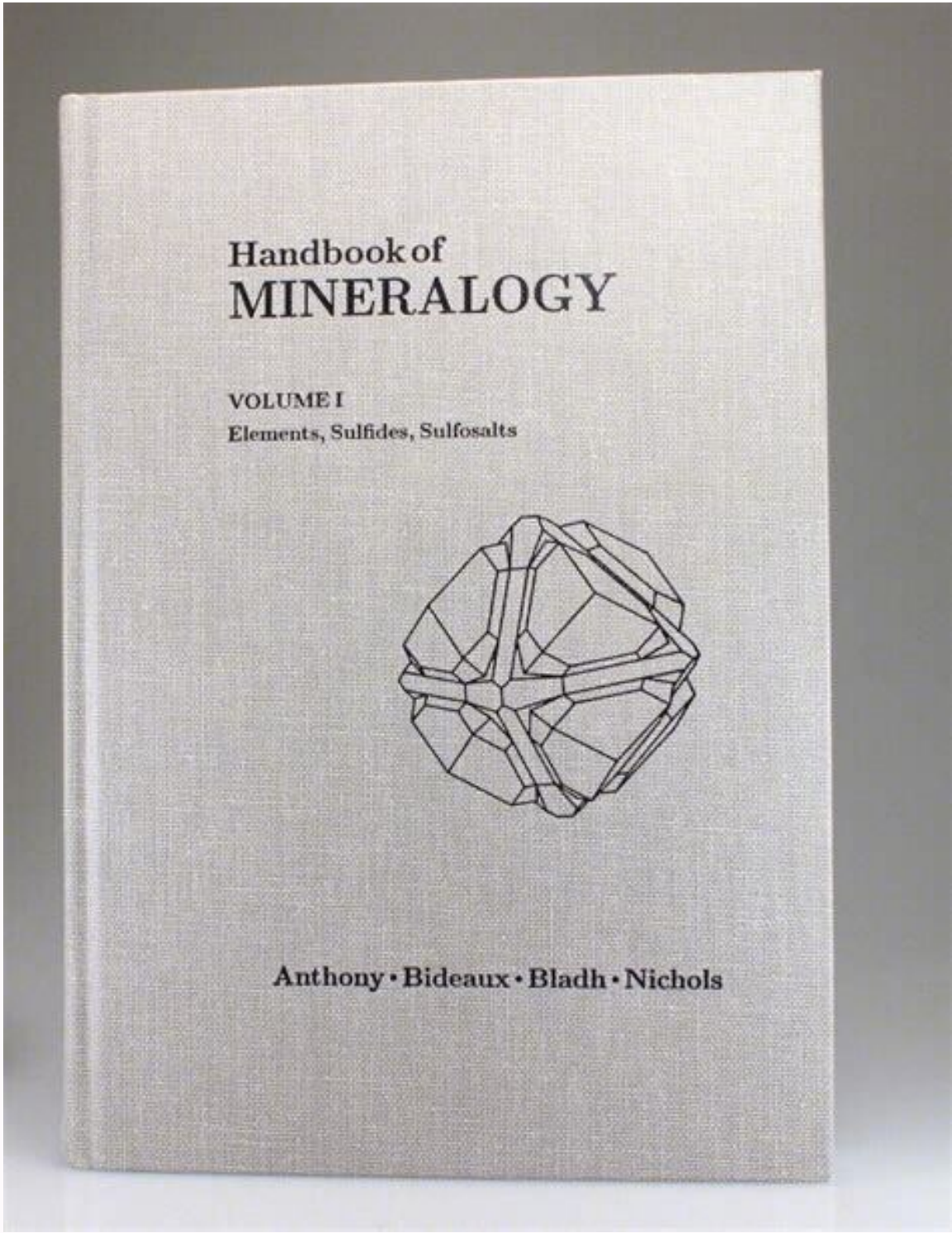
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Pyrrhotite crystal structure. Pyrrhotite mineral group. Pyrrhotite gold ore. Pyrrhotite flotation. Pyrrhotite ore.

Magnetic iron sulfide mineral PyrrhotiteBrassy, tabular crystals of pyrrhotite, with sphalerite and quartz, from Nikolaevskiy Mine, Primorskiy Kray, Russia. Specimen size: 5.3 x 4.1 x 3.8 cmGeneralCategoryMineralFormula(repeating unit)Fe1–xS (x = 0 to 0.125)IMA symbolPyh[1]Strunz classification2.CC.10Crystal systemMonoclinic, with hexagonal polytypesCrystal classPrismatic (2/m) (same H-M symbol)Space groupA2/aUnit cella = 11.88 Å, b = 6.87 Å, c = 22.79 Å; β = 90.47°; Z = 26IdentificationColorBronze, dark brownCrystal habitTabular or prismatic in hexagonal prisms; massive to granularCleavageAbsentFractureUnevenMohs scale hardness3.5 – 4.5LusterMetallicStreakDark grey – blackSpecific gravity4.58 – 4.65, average = 4.61Refractive indexOpaqueFusibility3SolubilitySoluble in hydrochloric acidOther characteristicsWeakly magnetic, strongly magnetic on heating; non-luminescent, non-radioactiveReferences[2][3][4] Pyrrhotite (pyrrhos in Greek meaning “flame-coloured”) is an iron sulfide mineral with the formula Fe(1-x)S (x = 0 to 0.125). It is a nonstoichiometric variant of FeS, the mineral known as troilite. Pyrrhotite is also called magnetic pyrite, because the color is similar to pyrite and it is weakly magnetic. The magnetism decreases as the iron content decreases, and troilite is non-magnetic.[5] Pyrrhotite is generally tabular and brassy/bronze in color with a metallic luster. The mineral occurs with mafic igneous rocks like norites, and may form from pyrite during metamorphic processes.[6] Pyrrhotite is associated and mined with other sulfide minerals like pentlandite, pyrite, chalcopyrite, and magnetite, and has been found globally. NiAs structure of basic pyrrhotite-1C. Pyrrhotite with pentlandite (late Paleoproterozoic, 1.85 G... | Flickr Microscopic image of Pyrrhotite under reflected light Structure Pyrrhotite exists as a number of polytypes of hexagonal or monoclinic crystal symmetry; several polytypes often occur within the same specimen. Their structure is based on the NiAs unit cell. As such, Fe occupies an octahedral site and the sulfide centers occupy trigonal prismatic sites.[7][page needed] Materials with the NiAs structure often are non-stoichiometric because they lack up to 1/8th fraction of the metal ions, creating vacancies. One of such structures is pyrrhotite-4C (Fe7S8). Here “4” indicates that iron vacancies define a superlattice that is 4 times larger than the unit cell in the “C” direction. The C direction is conventionally chosen parallel to the main symmetry axis of the crystal; this direction usually corresponds to the largest lattice spacing. Other polytypes include: pyrrhotite-5C (Fe9S10), 6C (Fe11S12), 7C (Fe9S10) and 11C (Fe10S11). Every polytype can have monoclinic (M) or hexagonal (H) symmetry, and therefore some sources label them, for example, not as 6C, but 6H or 6M depending on the symmetry.[2][8] The monoclinic forms are stable at temperatures below 254 °C, whereas the hexagonal forms are stable above that temperature. The exception is for those with high iron content, close to the troilite composition (47 to 50% atomic percent iron) which exhibit hexagonal symmetry.[9] Magnetic properties The ideal FeS lattice, such as that of troilite, is non-magnetic. Magnetic properties vary with Fe content. More Fe-rich, hexagonal pyrrhotites are antiferromagnetic. However, the Fe-deficient, monoclinic Fe7S8 is ferrimagnetic.[10] The ferromagnetism which is widely observed in pyrrhotite is therefore attributed to the presence of relatively large concentrations of iron vacancies (up to 20%) in the crystal structure. Vacancies lower the crystal symmetry. Therefore, monoclinic forms of pyrrhotite are in general more defect-rich than the more symmetrical hexagonal forms, and thus are more magnetic.[11] Monoclinic pyrrhotite undergoes a magnetic transition known as the Besnus transition at 30 K that leads to a loss of magnetic remanence.[12] The saturation magnetization of pyrrhotite is 0.12 tesla.[13] Identification Physical Properties Pyrrhotite is brassy, bronze, or dark brown in color with a metallic luster and uneven or subconchoidal fracture.[14] Pyrrhotite may be confused with other brassy sulfide minerals like pyrite, chalcopyrite, or pentlandite. Certain diagnostic characteristics can be used for identification in hand samples. Unlike other common brassy-colored sulfide minerals, pyrrhotite is typically magnetic (varies inversely with iron content).[14] On the Mohs hardness scale, pyrrhotite ranges from 3.5 to 4,[15] compared to 6 to 6.5 for pyrite.[16] Streak can be used when properties between pyrrhotite and other sulfide minerals are similar. Pyrrhotite displays a dark grey to black streak.[15] Pyrite will display a greenish black to brownish black streak.[16] chalcopyrite will display a greenish black streak.[17] and pentlandite leaves a pale bronze-brown streak.[18] Pyrrhotite generally displays massive to granular crystal habit, and may show tabular/prismatic or hexagonal crystals which are sometimes iridescent.[14] Diagnostic characteristics in hand sample include: brassy/bronze color with a grey/black streak, tabular or hexagonal crystals which show iridescence, subconchoidal fracture, metallic luster, and magnetic. Optical Properties Pyrrhotite is an opaque mineral and will therefore not transmit light. As a result, pyrrhotite will display extinction when viewed under plane polarized light and cross polarized light, making identification with petrographic polarizing light microscopes difficult. Pyrrhotite, and other opaque minerals can be identified optically using a reflected light ore microscope. The following optical properties[19] are representative of polished/puck sections using ore microscopy: Photomicrograph of pyrrhotite under reflected light appearing as cream-pink to beige irregular anhedral masses (5x/0.12 POL). Pyrrhotite typically appears as anhedral, granular aggregates and is cream-pink to brownish in color.[19] Weak to strong reflection pleochroism which may be seen along grain boundaries.[19] Pyrrhotite has similar polishing hardness to pentlandite (medium), is softer than pyrite, and harder than chalcopyrite.[19] Pyrrhotite will not display twinning or internal reflections, and its strong anisotropy from yellow to greenish-gray or grayish-blue is characteristic.[19] Diagnostic characteristics in polished section include: anhedral aggregates, cream-pink to brown in color and strong anisotropy. Occurrence Pyrrhotite is a rather common trace constituent of mafic igneous rocks especially norites. It occurs as segregation deposits in layered intrusions associated with pentlandite, chalcopyrite and other sulfides. It is an important constituent of the Sudbury intrusion (1.85 Ga old meteorite impact crater in Ontario, Canada) where it occurs in masses associated with copper and nickel mineralisation.[9] It also occurs in pegmatites and in contact metamorphic zones. Pyrrhotite is often accompanied by pyrite, marcasite and magnetite. Formation of Pyrrhotite in Rocks Pyrrhotite requires both iron and sulfur to form.[6] Iron is the fourth most abundant element in the Earth's continental crust (average abundance of 5.63 % or 56.300 mg/kg in the crust).[20] and so the majority of rocks have sufficient iron abundance to form pyrrhotite.[6] However, because sulfur is less abundant (average abundance of 0.035 % or 350 mg/kg in the crust).[20] the formation of pyrrhotite is generally controlled by sulfur abundance.[6] Also, the mineral pyrite is both the most common and most abundant sulfide mineral in the Earth's crust.[6] If rocks containing pyrite undergo metamorphism, there is a gradual release of volatile components like water and sulfur from pyrite.[6] The loss of sulfur causes pyrite to recrystallize into pyrrhotite.[6] Pyrrhotite can also form near black smoker hydrothermal vents.[6] Black smokers release high sulfur concentrations onto the sea floor, and when the surrounding rocks are metamorphosed, pyrrhotite can crystallize.[6] Later tectonic processes uplift the metamorphic rocks and expose pyrrhotite to the Earth's surface.[6] Distribution The United States Map of Pyrrhotite Potential Occurrences in the United States (Mauk and Horton, 2020; U.S. Geological Survey, 2019; Mindat.org, 2019). Pyrrhotite occurs in a variety of locations in the United States.[6][21][22][23] In the eastern United States, pyrrhotite occurs in highly metamorphosed rock that forms a belt along the Appalachian Mountains.[6] Pyrrhotite-bearing rocks are generally unseen in the central United States as the area is unmetamorphosed and underlain by sedimentary rocks which do not contain pyrrhotite.[6] Discontinuous belts that contain pyrrhotite are present in the western United States along the Sierra Nevada mountain range and Cascade Range extending into the northwestern United States.[6] Pyrrhotite may also be found west and south of Lake Superior.[6] Mining Locations Worldwide The following are some of the locations worldwide where pyrrhotite has been reported during mining: [15] Canada Location Mine Main Target Commodities British Columbia, Riondel Bluebell Mine[24] Cd, Cu, Au, Pb, Ag, Zn Québec Henderson No. 2 mine (Copper Rand mine)[25] Cu, Au Québec B&B Quarry, Sharwiniigan Crushed rock (Gabbro) for construction Québec Maskimo Quarry, Sharwiniigan Crushed rock (Gabbro) for construction The United States Location Mine Main Target Commodities Connecticut Becker Quarry (Becker's Quarry)[26] Not given, but abundant quartz, kyanite, and garnet are worthy of mentioning. Note: This was a quarry producing crushed rock aggregate for use in construction Australia Location Mine Main Target Commodities Tasmania Renison Bell Mine (Renison Mine)[27] Sn Brazil Location Mine Main Target Commodities Minas Gerais Morro Velho mine[28][29] Au, iron-ore[30] Italy Location Mine Main Target Commodities Tuscany Bottino Mine[31] Ag, sulfides[32] Kosovo Location Mine Main Target Commodities Mitrovica District Treпча Mine[33] Pb, Ag, Zn Etymology and history Named in 1847 by Ours-Pierre-Armand Petit-Dufrénoy.[34] "Pyrrhotite" is derived from the Greek word πυρρό, "pyrrhos", meaning flame-colored.[2] Issues If pyrrhotite-containing rocks are crushed and used as aggregate within concrete, then the pyrrhotite creates a problem in the production of concrete.[35] Pyrrhotite has been linked to crumbling concrete basements in Quebec, Massachusetts and Connecticut when local quarries included it in their concrete mixtures.[36][37][38] Many houses in Ireland, particularly in County Donegal, have also been affected by inclusion of rocks containing pyrrhotite in concrete blocks.[39][40] The iron sulfide it contains can naturally react with oxygen and water, and over time pyrrhotite breaks down into sulfuric acid and secondary minerals like ettringite, thaumasite and gypsum.[35][6] These secondary products occupy a larger volume than pyrrhotite, which expands and cracks the concrete leading to home foundation or block failure. [36][37][38][35][6] Uses of Pyrrhotite Other than a source of sulfur, pyrrhotite does not have specific applications.[41] It is generally not a valuable mineral unless significant nickel, copper, or other metals are present.[41][42] Iron is seldom extracted from pyrrhotite due to a complicated metallurgical process[41] It is mined primarily because it is associated with pentlandite, a sulfide mineral that can contain significant amounts of nickel and cobalt.[2] When found in mafic and ultramafic rocks, pyrrhotite can be a good indicator of economic nickel deposits.[41] Mineral Abbreviations Table of pyrrhotite mineral abbreviations, hñfufeyva Note: only use official IMA-CNMC symbol listed in bold text. Abbreviation Source Pyh IMA-CNMC[43] Po Whitney and Evans, 2010[44] The Canadian Mineralogist, 2019.[45] Pyrrhotite Synonyms Synonyms of the mineral pyrrhotite.[2] Magnetic Pyrite Magnetopyrite Magnetic Pyrites Pyrrhotine Pyrrhotite Magnetic Iron Pyrites Dipyrrite Kroeberite Vattenkies References ^ Warr, L.N. (2021). "IMA-CNMC approved mineral symbols". Mineralogical Magazine. 85 (3): 291–320. Bibcode:2021MinM...85...291W. doi:10.1180/mgm.2021.43.



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However, because sulfur is less abundant (average abundance of 0.035 % or 350 mg/kg in the crust),[20] the formation of pyrrhotite is generally controlled by sulfur abundance.[6] Also, the mineral pyrite is both the most common and most abundant sulfide mineral in the Earth's crust.[6] If rocks containing pyrite undergo metamorphism, there is a gradual release of volatile components like water and sulfur from pyrite.[6] The loss of sulfur causes pyrite to recrystallize into pyrrhotite.[6] Pyrrhotite can also form near black smoker hydrothermal vents.[6] Black smokers release high sulfur concentrations onto the sea floor, and when the surrounding rocks are metamorphosed, pyrrhotite can crystallize.[6] Later tectonic processes uplift the metamorphic rocks and expose pyrrhotite to the Earth's surface.[6] Distribution The United States Map of Pyrrhotite Potential Occurrences in the United States (Mauk and Horton, 2020; U.S. Geological Survey, 2019; Mindat.org, 2019). 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Note: This was a quarry producing crushed rock aggregate for use in construction Australia Location Mine Main Target Commodities Tasmania Renison Bell Mine (Renison Mine)[27] Sn Brazil Location Mine Main Target Commodities Minas Gerais Morro Velho mine[28][29] Au, iron-ore[30] Italy Location Mine Main Target Commodities Tuscany Bottino Mine[31] Ag, sulfides[32] Kosovo Location Mine Main Target Commodities Mitrovica District Treпча Mine[33] Pb, Ag, Zn Etymology and history Named in 1847 by Ours-Pierre-Armand Petit-Dufrénoy.[34] "Pyrrhotite" is derived from the Greek word πυρρῶς, "pyrrhos", meaning flame-colored.[2] Issues If pyrrhotite-containing rocks are crushed and used as aggregate within concrete, then the pyrrhotite creates a problem in the production of concrete.[35] Pyrrhotite has been linked to crumbling concrete basements in Quebec, Massachusetts and Connecticut when local quarries included it in their concrete mixtures.[36][37][38] Many houses in Ireland, particularly in County Donegal, have also been affected by inclusion of rocks containing pyrrhotite in concrete blocks.[39][40] The iron sulfide it contains can naturally react with oxygen and water, and over time pyrrhotite breaks down into sulfuric acid and secondary minerals like ettringite, thaumasite and gypsum.[35][6] These secondary products occupy a larger volume than pyrrhotite, which expands and cracks the concrete leading to home foundation or block failure. [36][37][38][35][6] Uses of Pyrrhotite Other than a source of sulfur, pyrrhotite does not have specific applications.[41] It is generally not a valuable mineral unless significant nickel, copper, or other metals are present.[41][42] Iron is seldom extracted from pyrrhotite due to a complicated metallurgical process[41] It is mined primarily because it is associated with pentlandite, a sulfide mineral that can contain significant amounts of nickel and cobalt.[2] When found in mafic and ultramafic rocks, pyrrhotite can be a good indicator of economic nickel deposits.[41] Mineral Abbreviations Table of pyrrhotite mineral abbreviations. Note: only use official IMA-CNMNC symbol listed in bold text. Abbreviation Source Pyh IMA-CNMNC[43] Po Whitney and Evans, 2010[44] The Canadian Mineralogist, 2019.[45] Pyrrhotite Synonyms Synonyms of the mineral pyrrhotite.[2] Magnetic Pyrite Magnetopyrite Magnetic Pyrites Pyrrhotine Pyrrhotite Magnetic Iron Pyrites Dipyrrite Kroeberite Vattenkies References ↑ Warr, L.N. (2021), "IMA-CNMNC approved mineral symbols", Mineralogical Magazine, 85 (3): 291–320. Bibcode:2021MinM...85..291W. doi:10.1180/mgm.2021.43. S2CID 235729616. ↑ a b c d e "Pyrrhotite". *yokohe* Mindat.org. Retrieved 2009-07-07. ↑ luge ↗ "Pyrrhotite" (PDF). Ruiff.geo.arizona.edu. luguyunimehe Retrieved 2015-07-10. ↑ "Pyrrhotite Mineral Data". Webmineral.com. Retrieved 2015-07-10. ↑ Haldar, S. K. disawani (2017). 57144-X. ↑ a b Klein, Cornelis and Cornelius S. 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"Pyrrhotite". Encyclopedia Britannica (11th ed.). Retrieved from " Links to other databases for Pyrrhotite : 1 - Alkali-Nuts(English) 2 - Alkali-Nuts(Francais) 3 - Am. Min. Crystal Structure Database 4 - Amethyst Galleries' Mineral Gallery 5 - Athena 6 - EUROmin Project 7 - Ecole des Mines de Paris 8 - Franklin Minerals(Dunn) 9 - Franklin Minerals(Palache) 10 - GeoScienceWorld 11 - Google Images 12 - Google Scholar 13 - Handbook of Mineralogy (MinSocAm) 14 - Handbook of Mineralogy (UoGa) 15 - HyperPhysics 16 - MinDAT 17 - Mineralenatlas (Deutsch) 18 - NSDL Reciprocal Net (JAVA) 19 - Online Mineral Museum 20 - Philatelic Mineralogy 21 - QUT Mineral Atlas 22 - Ruff.Info 23 - Scandinavian mineral gallery 24 - WWW-MINCRYST Search for Pyrrhotite using: [AOL] [Bing] [Dog Pile] [GeoScienceWorld] [HotBot] [Ixquick] [Lycos] [MAMMA] [Sciрус] [Teoma] [WebCrawler] [Wikipedia] [YAHOO] Visit our Advertisers for Pyrrhotite : A Bijoux Google Search for Pyrrhotite Adam's Minerals Google Search for Pyrrhotite Cape Minerals Google Search for Pyrrhotite Dakota Matrix Minerals Google Search for Pyrrhotite Excalibur Mineral Corp. Google Search for Pyrrhotite Exceptional Minerals Google Search for Pyrrhotite John Betts Fine Minerals Search for Pyrrhotite McDougall Minerals Google Search for Pyrrhotite Mineral News Website Link Rock and Mineral Shows Google Search for Pyrrhotite Weinrich Minerals, Inc. Google Search for Pyrrhotite Ask about Pyrrhotite here : Ask-A-Mineralogist from the Mineralogical Society of America Mindat.org's Discussion Groups Original Rockhounds Discussion Group Rockhounds Discussion Group on Yahoo Groups Mineral Discussion Forum from Fabre Minerals - also available in Español Print or Cut-and-Paste your Pyrrhotite Specimen Label here : Pyrrhotite Fe(1-x)S (x=0-0.17) Dana No: 02.08.10.01 Strunz No: 02.CC.10 Locality: Notes: