MICROCRYSTALLINE GRAPHITE P03

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IDENTIFICATION

SYNONYM: "Amorphous graphite" is a technically incorrect but commonly used commercial term for the same product.

COMMODITY: Microcrystalline graphite.

EXAMPLES (British Columbia (MINFILE #) - *Canada/International*): *Kellog Mine in Moradillos (State of Sonora, Mexico), Kaiserberg, Styria region (Austria) and Velké Vrbno-Konstantin (Czech Republic)* .

GEOLOGICAL CHARACTERISTICS

CAPSULE DESCRIPTION: Most amorphous graphite deposits are formed by contact or regional metamorphism of coal beds or other highly carbonaceous sedimentary rocks. Deposits may consist of several beds or lenses, each a few metres thick and up to several kilometres in length. Typical host rocks are quartzites, phyllites, schists and metagraywackes.

TECTONIC SETTINGS: Continental margin or intracratonic basins.

DEPOSITIONAL ENVIRONMENT / GEOLOGICAL SETTING: Near shore sedimentary rocks with intercalated coal seams, or other highly carbonaceous sedimentary beds, that are metamorphosed by nearby igneous intrusions or affected by regional metamorphism.

AGE OF MINERALIZATION: Most of the deposits are Mississippian to Cretaceous in age or younger.

HOST/ASSOCIATED ROCK TYPES: The host rocks are coal seams or other highly carbon-rich rock types and their low to medium grade metamorphic equivalents. Amorphous graphite deposits occur within sequences of chlorite and muscovite schists, phyllites, quartzites, metagraywackes, limestones, sandstones and conglomerates which may be cut by diabasic or granitic intrusions with associated andalusite-bearing hornfels.

DEPOSIT FORM: Stratiform or lens-shaped; beds may be deformed and/or repeated by folding and faulting. Pinching and swelling of beds is common. Deposits may consist of several beds, each one to few metres thick. They may be exposed for hundreds of metres to several kilometres in strike length.

TEXTURE/STRUCTURE: Graphite-bearing beds may contain lenses of hangingwall or footwall host rocks and are characterised by abundant slickensides. Graphite ore is schistose or massive.

ORE MINERALOGY [Principal and *subordinate*]: Microcrystalline graphite

GANGUE MINERALOGY [Principal and *subordinate*]: Meta-anthracite *± anthracite ± quartz ± mica ± coke ± clay ± pyrite and other sulphides ± apatite ± gypsum.*

ALTERATION MINERALOGY: N/A.

WEATHERING: Weathered outcrops of microcrystalline graphite are typically dull, porous and dark-gray to black.

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ORE CONTROLS: Coal beds invaded by intrusive rocks or sedimentary sequences with coal seams or other carbon-rich rocks metamorphosed typically to greenschist facies. Size, grade and mineral impurities of the graphite deposit depend on the characteristics of the original coal seams and carbon-bearing or carbonaceous sediments. Degree of metamorphism controls the degree of graphitization. Graphite may grade into coal with increasing distance from the heat source. Temperatures required for graphitization are lower under shear conditions. Faults and folds may control the thickness or repetition of graphite beds.

GENETIC MODELS: Graphitization can be described as an extreme case of coal maturation. Coal maturation involves the following sequence: peat - lignite - bituminous coal - semi-anthracite - anthracite - meta-anthracite - microcrystalline graphite. Source of heat in contact-metamorphic environment may be plutons, dikes or sills adjacent to coal beds.

ASSOCIATED DEPOSIT TYPES: Coal deposits, (A03, A04, A05). Some coal beds may be only partially converted into graphite. Expending shale (R02) and bentonite deposits (E06) are commonly associated with coal. Andalusite deposits (P01) may be present in cases where graphite is formed by contact metamorphism.

COMMENTS: Although several areas appear favorable for the formation of amorphous graphite there are no known deposits in British Columbia. Meta-anthracite is reported at Guess Creek near Smithers and Flint Creek near Hazelton.

EXPLORATION GUIDES

GEOCHEMICAL SIGNATURE: Graphite may be present in residual soils. Positive vanadium and nickel anomalies and negative boron anomalies associated with graphite beds were reported by Tichy and Turnovec (1978). This enrichment is probably related to the trace element content of the protolith, therefore, each deposit may have its own geochemical characteristics. It is unlikely that the chemical signature could be used effectively in grassroots mineral exploration

GEOPHYSICAL SIGNATURE: Graphite deposits have been located using induced polarization (IP), resistivity, ground and airborne electromagnetic (EM), spontaneous potential (SP) and audiomagnetotelluric (AMT) surveys. Outcrops may have associated radioactivity because of trace amounts of uranium.

OTHER EXPLORATION GUIDES: The most important regional exploration guides for high-grade amorphous deposits are: 1) coal beds invaded by igneous rocks or 2) coal seams traced across regional metamorphic isograds into low to medium-grade metamorphic areas.

ECONOMIC FACTORS

TYPICAL GRADE AND TONNAGE: The mean size of the deposits reported by Bliss and Sutphin (1992) is 4 900 000 tonnes. Major active mines contain over 80 per cent carbon, but the average grade of some of the European deposits may be as low as 55%. Some beds may be only partly graphitized.

ECONOMIC LIMITATIONS: Mines are mainly open pit, however underground mining is possible depending on the thickness and orientation of the ore. Prices of amorphous graphite are substantially lower than the prices of the crystalline flake graphite. The ore is commonly hand-sorted. Quantity and type of impurities and ash content are major concerns. The degree of graphitization varies from one deposit to an other and as a result, proportions of microcrystalline graphite to carbon also varies.

END USES: Microcrystalline graphite is used in brake linings, foundry applications, lubricants, pencils, refractories, and steel making. The graphite may contain several percent volatile material. In fact, some meta-anthracite from South Korea is marketed as microcrystalline graphite, but it may be due largely to export restrictions on energy exports from Korea.

IMPORTANCE: Metamorphosed coal beds are the main source of microcrystalline graphite. For most applications, synthetic graphite and crystalline graphite may be substituted for amorphous graphite but at increased cost.

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