ULTRAMAFIC-HOSTED CHRYSOTILE ASBESTOS M06

by Z.D. Hora

IDENTIFICATION

SYNONYMS: Quebec-type asbestos, serpentine-hosted asbestos, ultramafic-intrusion hosted asbestos.

COMMODITIES (BYPRODUCTS): Chrysotile asbestos (nephrite jade at Cassiar).

EXAMPLES (British Columbia (MINFILE #) - *Canadian/International*): Cassiar (104P005), McDame (104P084), Letain (104I006), Ace (104K025), Asbestos (082 KNW075); *Thetford Mines, Black Lake, Asbestos (Quebec, Canada), Belvidere Mine (Vermont, USA), Coalinga (California, USA), Cana Brava (Brazil), Pano Amiandes (Cyprus), Bazhenovo (Russia), Barraba (New South Wales, Australia), Barberton (Transvaal, South Africa).*

GEOLOGICAL CHARACTERISTICS

CAPSULE DESCRIPTION: Chrysotile asbestos occurs as cross fibre and/or slip fibre stockworks, or as less common agglomerates of finely matted chrysotile fibre, in serpentinized ultramafic rocks. Serpentinites may be part of ophiolite sequence in orogenic belts or synvolcanic intrusions of Archean greenstone belts.

TECTONIC SETTINGS: Chrysotile deposits occur in accreted oceanic terranes, usually part of an ophiolite sequence, or within Alpine - type ultramafic rocks. They are also found in synvolcanic ultramafic intrusions of komatiitic affinity in Archean greenstone belts. In British Columbia the significant occurrences are found in the Slide Mountain, Cache Creek and Kootenay terranes.

DEPOSITIONAL ENVIRONMENT / GEOLOGICAL SETTING: The serpentine host must have a nonfoliated texture and must be situated near a fault that is active during a change in the orientation of the regional stress from dip-slip to strike-slip fault motion. The serpentinite must be in the stability field of chrysotile when the change in orientation occurs. Subsequent deformation or temperature increase may destroy the fibre and result in a different mineralogy.

AGE OF MINERALIZATION: Precambrian to Tertiary. Deposits in British Columbia are considered Upper Cretaceous, deposits in southeastern Quebec formed during a relatively late stage of Taconic orogeny (late Ordovician to early Silurian), deposits in Ungava and Ontario are Precambrian. Chrysotile asbestos deposits are generally considered to be syntectonic and to form during the later stages of deformation.

HOST/ASSOCIATED ROCK TYPES: Serpentinite, dunite, peridotite, wehrlite, harzburgite, pyroxenite. Associated rocks are rodingite and steatite.

DEPOSIT FORM: In plan orebodies are equidimensional to somewhat oblate zones from 100 to 1000 metres in diameter within masses of serpentinized ultramafic rock. The vertical distribution of mineralized zones may be in the order of several hundreds of metres.

TEXTURE/STRUCTURE: Asbestos veins fill tension fractures in serpentinized ultramafic rocks or form a matrix of crushed and brecciated body of serpentinite. Usually, the orebodies grade from numerous stockwork veins in the centre to a lower number of crosscutting veins on the fringes. Cross-fibre veins, where the chrysotile fibres are at a high angle to the vein walls, are more abundant than slip fibre veins which parallel the vein walls. Individual veins are up to several metres in length and for the most part less than 1 cm thick, but may be up to 10 cm thick. In some deposits, powdery agglomerates of finely matted chrysotile form the matrix for blocks and fragments of serpentinite rock.

ORE MINERALOGY [Principal and *subordinate*]: Chrysotile.

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GANGUE MINERALOGY [Principal and *subordinate*]: Gangue minerals in chrysotile veinlets are brucite and magnetite. Antigorite and lizardite may also be present in association with chrysotile veining.

ALTERATION MINERALOGY: Chrysotile and associated minerals are alteration products of ultramafic rocks. This process which starts as serpentinization, may be pervasive, but also fracture controlled and incomplete with serpentine surrounding peridotite (or other rock) cores. In relationship to changes in temperature, pressure and the fluid chemistry a variety of minerals from lizardite to talc and antigorite, or tremolite can be produced. Since the serpentinization of ultramafic rocks is frequently a multiple stage process, which can be either prograde or retrograde, many deposits contain minerals which do not form in the same stability field. Therefore, the alteration and gangue mineralogy are practically identical.

WEATHERING: In northern climates, only physical weathering of chrysotile and the serpentinized host rock takes place. Brucite and carbonates may be removed in solution and precipitated as hydromagnesite elsewhere. Lateritic soils should be expected in tropical climates.

ORE CONTROLS: Chrysotile veinlets are often best developed in massive serpentinite bodies with no schistose fabric. Chrysotile stability field; proximity to a fault that is active during change in the orientation of stress field; limited subsequent deformation and no subsequent medium to high grade metamorphism after the asbestos formation. Asbestos veins fill tension fractures in serpentinized ultramafic rocks or form a matrix of crushed and brecciated body of serpentinite.

GENETIC MODELS: Chrysotile asbestos deposits develop in nonfoliated, brittle ultramafic rocks under low grade metamorphic conditions with temperatures of 300 ± 50°C and water pressures less than 1 kbar. The chrysotile forms as the result of fluid flow accompanied by deformation where water gains access to partly or wholly serpentinized ultramafics along fault and shear zones.

ASSOCIATED DEPOSIT TYPES: Spatial association (but no genetic relationship) with podiform chromite deposits (M03) and jade (Q01) in ophiolitic sequences. Cyptocrystalline magnesite veins (I17), ultramafic-hosted talc-magnesite (M07) and anthophyllite asbestos deposits may be genetically related.

COMMENTS: Anthophyllite, a variety of amphibole, is another asbestiform mineral. Production of anthophyllite has been limited; Green Mountain mine in North Carolina is the only North American past producer.

EXPLORATION GUIDES

GEOCHEMICAL SIGNATURE: None.

GEOPHYSICAL SIGNATURE: Magnetite, which is a product of both sepentinization and the formation of chrysotile, can produce well defined, magnetic anomalies. Gravity surveys can distinguish serpentinite from the more dense (~20%) peridotite.

OTHER EXPLORATION GUIDES: Asbestos fibres found in soils. Massive, brittle and unsheared ultramafic bodies which are partly or fully serpentinized in proximity to faults and shears.

ECONOMIC FACTORS

TYPICAL GRADE AND TONNAGE: Total fibre content of commercial deposits is between 3 and 10%, the tonnage is between 500 000 to 150 million tons (in the asbestos industry fibre length is a critical parameter as well). In British Columbia, company reports indicate the Cassiar mine produced 31 Mt grading 7 to 10% fibre. There are however 25 Mt of tailings with 4.2% recoverable short fibre. Another 7.3 Mt geological reserves was left in the pit. The adjacent McDame deposit has measured reserves of 20 Mt @ 6.21% fibre and estimated geological reserves of 63 Mt. In the Yukon Clinton Creek produced 15 Mt @ 6.3% fibre. The following figures are from Duke (1996) and include past production plus reserves: Jeffrey, Quebec: 800 Mt @ 6% fibre, Bell-Wing-Beaver, Quebec: 250 Mt @ 6% fibre, British Canadian, Quebec: 150 Mt @ 6% fibre, Advocate, Newfoundland: 60 Mt @ 3% fibre. A relatively few deposits have been developed to mine agglomerates of finely matted chrysotile fibre which have much higher grades.

ECONOMIC FACTORS

TYPICAL GRADE AND TONNAGE (continued): The very large Coalinga deposit in California has reported short fibre recoveries in the order of 35 to 74%. The Stragari mine in Serbia is recovering 50-60% fibre.

ECONOMIC LIMITATIONS: Fibre lengths may vary significantly within and between deposits; stockwork mineralization is typically more economically attractive if the proportion of longer fibres is higher. Typically, the fibre value starts at CDN$180/ton for the shortest grade and reaches CDN$1750 for the longest (Industrial Minerals, 1997).

END USES: Asbestos-cement products; filler in plastics; break lining and clutch facings; asbestos textiles; gaskets; acoustic and electric and heat insulation.

IMPORTANCE: Ultramafic-hosted chrysotile is the only source of asbestos in North America and considered the least hazardous of commercial asbestos minerals. During the 1980s the market for asbestos in many countries declined due to health hazard concerns.

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