SEDIMENTARY KAOLIN E07

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IDENTIFICATION

SYNONYMS: Secondary kaolin deposits, fireclay, underclays, high-alumina clay, china clay.

COMMODITIES (BYPRODUCTS) Kaolin (many different grades for specific applications), ceramic clay, ball clay, refractory clay (cement rock, bauxite, silica sand).

EXAMPLES (British Columbia (MINFILE #) - *Canada/International*): Sumas Mountain (92GSE004, 92GSE024), Blue Mountain (92GSE028), Lang Bay (92F137), Quinsam (92F319), Giscome Rapids (93J020); *Cypress Hills (Alberta, Canada), Eastend, Wood Mountain, Ravenscrag (Saskatchewan, Canada), Moose River Basin (Ontario, Canada), Shubenacadie Valley (Nova Scotia, Canada), Aiken (South Carolina, USA), Wrens, Sandersville, Macon-Gordon, Andersonville (Georgia, USA), Eufaula (Alabama, USA), Weipa (Queensland, Australia), Jari, Capim (Brazil).*

GEOLOGICAL CHARACTERISTICS

CAPSULE DESCRIPTION: Beds, lenses and saucer-shaped bodies of kaolinitic claystones hosted by clastic sedimentary rocks, with or without coaly layers or coal seams. They usually occur in freshwater basins filled with sediments derived from deeply weathered, crystalline feldspathic rocks.

TECTONIC SETTINGS: Low-lying coastal plains at continental edge; extension basins in orogenic belts; stable continental basins; back arc basins.

DEPOSITIONAL ENVIRONMENT / GEOLOGICAL SETTING: Clay beds are generally deposited in low energy environments within freshwater basins. Temperate to tropical climatic conditions can produce intensive kaolinitic weathering of feldspathic rocks of granitic composition. The kaolin is then eroded and transported to estuaries, lagoons, oxbow lakes and ponds.

AGE OF MINERALIZATION: Most of the world class deposits are Upper Cretaceous to Eocene age. Some "fireclay" and "underclay" deposits are Late Carboniferous.

HOST/ASSOCIATED ROCK TYPES: Kaolin beds are associated with variably kaolinitic, micaceous sandstones within mudstone, siltstone, sandstone and conglomerate sequences which often are cross-bedded. Coal (sub-bituminous and liqnite) may be associated with kaolin beds. Diatomite may also be present.

DEPOSIT FORM: Beds exhibit variable thickness, usually a few metres; sometimes multiple beds have an aggregate thickness of approximately 20 metres. Deposits commonly extend over areas of at least several square kilometers.

TEXTURE/STRUCTURE: Kaolin is soft and exhibits conchoidal or semiconchoidal fracture; it can be bedded or massive. Most kaolins will slake in water, but some "flint" varieties break into smaller angular fragments only. Depending on kaolin particle size and presence of organic matter, some clays may be very plastic when moist and are usually called "ball clays".

ORE MINERALOGY [Principal and *subordinate*]: Kaolinite, *halloysite, quartz, dickite, nacrite, diaspor, boehmite, gibbsite.*

GANGUE MINERALOGY [Principal and *subordinate*]: Quartz, *limonite, goethite, feldspar, mica, siderite, pyrite, illmenite, leucoxene, anatas.*

WEATHERING: The kaolin forms by weathering which results in decomposition of feldspars and other aluminosilicates and removal of fluxing components like alkalies or iron. Post depositional weathering and leaching can produce gibbsitic bauxite. In some deposits, post depositional weathering may improve crystallinity of kaolin particles and increase the size of crystal aggregates.

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ORE CONTROLS: The formation and localization of clay is controlled by the location of the sedimentary basin and the presence of weathered, granitic rocks adjacent to the basin, particularly rapidly eroding paleotopographic highs.

GENETIC MODELS: Ideal conditions to produce kaolinitic chemical weathering are high rainfall, warm temperatures, lush vegetation, low relief and high groundwater table. The kaolin is eroded and transported by streams to a quiet, fresh or brackish, water environment. Post-depositional leaching, oxidation, and diagenesis can significantly modify the original clay mineralogy with improvement of kaolin quality.

ASSOCIATED DEPOSIT TYPES: Peat (A01), coal seams (A02, A03, A04), paleoplacers (CO4), some bentonites (EO6), lacustrine diatomite (FO6).

EXPLORATION GUIDES

GEOCHEMICAL SIGNATURE: None. Enrichment in Al does not provide sufficient contrast with host sediments.

GEOPHYSICAL SIGNATURE: Apparent resistivity and refraction seismic surveys can be used in exploration for fireclay beds.

OTHER EXPLORATION GUIDES: Most readily ascertainable regional attribute is sedimentary basins with Upper Cretaceous and Eocene unconformities. Within these basins kaolin occurs with sediments, including coal seams, deposited in low energy environments.

ECONOMIC FACTORS

TYPICAL GRADE AND TONNAGE: Published data on individual deposits are very scarce. Deposits in Georgia, USA contain 90 to 95% kaolinite. Individual Cretaceous beds are reported to be up to 12 m thick and extend more than 2 km while those in the Tertiary sequence are 10 to 25 m thick and up to 18 km along strike. The Weipa deposit in Australia is 8 to 12 m thick and contains 40 to 70% kaolinite. The Jari deposit in Brazil is reported to contain more than 250 Mt of "good, commercial grade kaolin". Over 200 Mt of reserves "have been proven" at Capim deposit in Brazil. Ball clay deposits in Tennessee and Kentucky consist of kaolin with from 5 to 30% silica; individual deposits may be more than 9 m thick and extend over areas from 100 to 800 m long and up to 300 m wide.

ECONOMIC LIMITATIONS: Physical and chemical properties affect end use. Physical properties include brightness, particle size distribution, particle shape and rheology. Limonite staining is a negative feature. The high level of processing required to meet industry specifications and minimize transportation cost to the end user are the main limiting factors for kaolin use. While local sources compete for low value markets, high quality products may be shipped to users several thousand km from the plant. Most production is from open pits; good quality fireclay seams more than 2 meters thick are sometimes mined underground. Typically, paper coating grade sells for up to US$120, filler grade for up to US$92 and sanitary ceramics grade for $US55 to $65 per short ton (Industrial Minerals, 1997). Refractory and ball clay prices are within the same range.

END USES: The most important use for kaolin is in the paper industry, both as a filler and coating pigment. A variety of industrial filler applications (rubber, paints, plastics, etc.) are another major end use. Kaolin's traditional use in ceramic products is holding steady, but the refractory use has declined substantially in the last two decades because of replacement by other high performance products.

IMPORTANCE: One of the most important industrial minerals in North America. Over 11 Mt is produced annually and production is on a steady increase.

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Draft # 3a December 15, 1997