THE FORUM ON THE GEOLOGY OF INDUSTRIAL MINERALS

56th Annual Meeting, Georgia, VIRTUAL

Saturday, October 10th, 2020, Session 2 Presentations:

9:00 - 9:05 AM, Welcome

9:05 - 9:35 AM, Roger S. Austin, PhD, PG, Milledgeville, GA, "Bauxite, Kaolin, a Meteor, Volcanism, and the Early Tertiary Super-Pluvial Climate in Georgia"

9:40 – 10:10 AM, Steve Stokowski, Stone Products Consultants, Lawrenceville, GA, "Uses for Quarry Fines from Aggregate Plants in the Southeast"

10:15 – 10:45 AM, W. Crawford Elliott, PhD, Georgia State University, Daniel J. Gardner, Georgia State Univ., Parkash Malla, PhD, Thiele Kaolin Co., Ed Riley, Thiele Kaolin Co., & Ya Peng Yu, PhD, NanoEarth, Virginia Institute of Technology and State University, "Rare Earth Minerals in Kaolin Grit Fraction"

10:45 – 11:00 AM, Questions and Answers

11:05 – 11:35 AM, Alex Glover, PG, Active Minerals International, Little Switzerland, NC, America's First Kaolin- The Cherokee-Wedgewood Connection

ABSTRACTS, SESSION 2:

Bauxite, Kaolin, a Meteor, Volcanism, and the Early Tertiary Super-Pluvial Climate in Georgia

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Bauxite and kaolin laterites developed across middle Georgia and the adjoining coastal states in the Early Tertiary as the great Cretaceous sea retreated and exposed ancient crystalline rocks and Late Cretaceous sedimentary strata. Sea level fluctuations brought new periods of inundation. Erosion of upland deposits provided bauxite- and kaolin-enriched detritus to form new sedimentary layers. Subsequent retreat of the sea exposed even these sediments to laterization. This 18 My episode lasted into the Early Eocene. Formation of bauxite and kaolin also took place in Australia, South America, Central Africa and elsewhere. The formation of the typical layered sequence of the bauxite-over-kaolin (gibbsite-over-kaolinite or $AlOH_3$-over-$Al_4Si_4O_{10}(OH)_8$), requires a heavy flux of ground water with extremely low concentrations of alkalis and silica. To achieve this globally requires a prolonged super-pluvial event. Consequences of the Chicxulub meteor or asteroid impact 66.0 Mya and the extraordinary volcanism of the Deccan plateau 67.4 Mya have been called on to explain the mass extinction as the Cenozoic Era began. Both would charge the atmosphere with particulate matter, CO_2, and SO_2. Acidic rainfall, elevated global temperatures, and acidified oceans may have resulted. Inference of warming and a Late Paleocene Thermal Maximum (LPTM)

based on carbon and oxygen isotope ratios in ocean sediments could have been exaggerated by the lowering of heavy isotope ratios brought about by heavy rainfall. The long duration of the event might reflect an earlier climatic tipping point brought about by the two episodes. The LPTM could have begun then, peaked at the Late Paleocene, and declined thereafter. In the Southeastern US, the bauxite has been substantially resilicated to form kaolin. Kaolin also formed by resilication of bauxite. This kaolin can be differentiated from kaolin that formed beneath the early bauxite and kaolin formed from younger sedimentary deposits by their contrasting textures and minor mineral components.

Uses for Quarry Fines from Aggregate Plants in the Southeast

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Quarry fines, the material washed from construction aggregate, could potentially yield over 100 industrial products in the abrasive, agricultural, ceramic, construction, mineral co-product, mineral filler, and pollution-control categories. The potentially highest-volume uses are in construction, agriculture, and pollution control. The over 1-billion ton recoverable stockpiled resource is sustainable with the estimated 350-million tpy annual production.

The materials usually have inherently high moisture contents, about 20-30% when recovered from a settlement pond and decreasing to 5-15% during stockpiling. Pond clays from sand and gravel processing have the highest moisture contents; associated flume sands have the lowest. Pond screenings from crushed stone or slag washing usually have about 20-25% moisture upon recovery. The fine materials can be dewatered with cyclones, thickeners, and filter presses or even rotary dried in a variable speed dryer. The optimum potential products take advantage of the fineness while minimizing the potentially negative impact of the high moisture content, or the presence of agglomerates in moisture-reduced fine products. High fineness materials are valuable in chemical applications or for intermixing with fine wet materials (such as in brick manufacture). A high moisture content can be beneficial during further processing, such as mineral recovery or chemical beneficiation, or if the material is added back into standard aggregate products.

In the Southeastern US, successful products from quarry fines include these application areas: as manufactured soils and agricultural sands, as cement stabilized base in Inverted Pavement construction, as engineered concrete sand with improved shape and yield, as drying sand for sludge, and as feldspathic sand for a variety of Industrial Minerals applications.

Rare-Earth Elements in Kaolin Grit Fraction

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The heavy mineral subfractions were separated from grit fractions from two kaolin producing units (Cretaceous Buffalo Creek Member of the Galliard Formation and the middle Eocene Jeffersonville Member of the Huber Formation) in the Georgia Coastal Plain. The total concentrations of the rare-earth elements varied from 0.16 (Jeffersonville Member) to 0.50 wt. % (Buffalo Creek). The heavy mineral subfractions were enriched in the heavy rare-earth elements (Y, Gd-Lu) from 10 to 150 times relative to their concentrations in the Upper Continental Crust (UCC). This heavy rare-earth element enrichment differed from the typical enrichment pattern of the light rare-earth elements found in crustal rocks. The heavy mineral subfraction was composed of titanium oxide minerals (anatase, rutile), zircon, and trace staurolite through X-ray diffraction measurements. Xenotime was observed using scanning electron microscopy with energy dispersive spectroscopy. Xenotime contained 1 - 2.6 wt. percent of Dy, Er, Gd, and Yb. Xenotime and zircon contained the rare-earth elements in these heavy mineral subfractions. The heavy mineral subfractions of kaolin grit comprised a novel domestic resource of the rare-earth elements.

America's First Kaolin- The Cherokee-Wedgewood Connection

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America's first kaolin was mined and used by Native Americans before settlers arrived in the New World. Evidence exist that Native Americans mined kaolin in and near Macon County, NC and mica in the Sylva/Franklin and Spruce Pine Mining Districts of North Carolina. The Primary (formed insitu) kaolin was used by Native Americans for clay slurry chinking and surfacing of the exterior and interior of their houses and for making tobacco smoking pipes in the Macon County NC Area. They desired this clay because the mica in it made their houses sparkle and shine.

The clay was formed insitu from the weathering of feldspar from the Lower Devonian age Franklin/Sylva Pegmatite District. The weathering of this roughly 65% feldspar composition has formed shallow zones of white kaolin clay.

The civilized world had known about ceramic devices and materials since the Chinese discovery from Gaoling Shan Mountain in the Jiangxi Province which led to the exploration and pursuit of this material. In the 18 Century, English potter Josiah Wedgewood had heard off a Philadelphia Quaker named Andrew Duche who was a colonial potter who had established himself in Savanah in 1737. Duche was getting his clay from the Cherokee Indians in what would become North Carolina in 1789. Josiah Wedgewood hired Charleston planter Thomas Griffiths in 1766 to travel to the Cherokee town of Ayoree and Iotla towns to search and acquire the Cherokee clay. Griffiths had great struggles and challenges on the 310-mile wilderness journey from Charleston, SC to Franklin, NC but did find and acquire approximately 5 tons of the elusive clay and returned with the oxen pulled wagons of clay. The clay was loaded and shipped to the Wedgewood operations at Staffordshire England. The Cherokee clay led to exquisite porcelain and development of the famous Wedgewood Queens Ware, Encaustic Ornamentation, and Jasperware. This new ceramic production was capable due to the very fine quality of the Cherokee clay which, unlike any other, led to great wealth of the Wedgewood family and a surprise consequence.