A novel occurrence of the Rare-earth elements in kaolin, Georgia Coastal Plain.

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Acknowledgements

The data on the rare-earth elemental compositions presented later in this talk is from Dan Gardner's M.S. Thesis, GSU.

Gardner, Daniel J., "A Study of Mineral Impurities within the Georgia Kaolins." Thesis, Georgia State University, 2016. https://scholarworks.gsu.edu/geosciences_theses/101

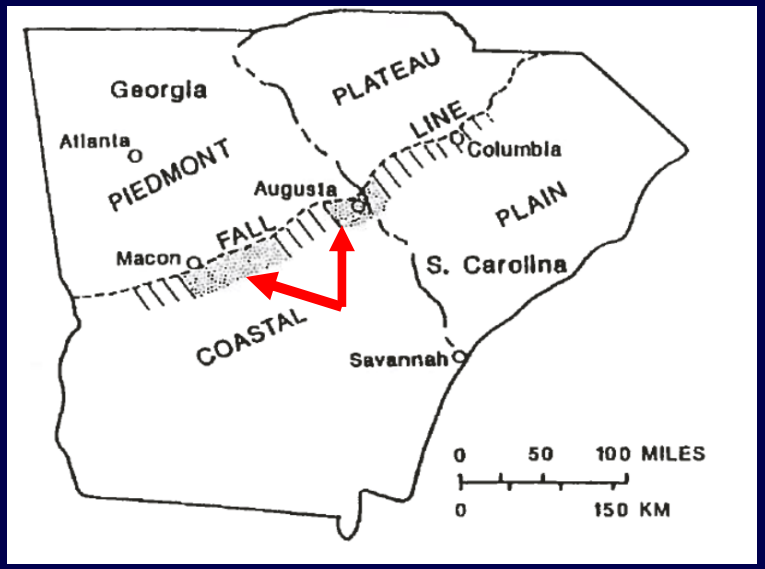
Elliott, W.C., Gardner, D.J., Malla, P., and Riley, E., 2018, A new look at the rare-earth elements in the Georgia Kaolins: Clays and Clay Minerals, v. 66, p. 209-224. doi: 10.1346/CCMN.2018.064096.

Elliott, W.C., Gardner, D.J., Malla, P., and Riley, E., 2020, Extracting rare earth elements from a gangue heavy fraction. *US Patent No. 10,688,501*. Washington D.C., U.S. Patent and Trademark Office. Assignee: Georgia State University Research Foundation, Thiele Kaolin Company. Granted June 23, 2020.

Thiele Kaolin Company provided the samples for our study.

NanoEarth (Dr. Ya-Peng Yu) provided SEM imagery (NSF – Funded Center, National Nanotechnology Coordinated Infrastructure). NanoEarth is housed at Virginia Tech.

Georgia Kaolins: What? Where? Why?



- A white sedimentary deposit of clay (< 2 micron) composed largely of kaolinite and a small fraction of coarse (sand) minerals (grit). [KaMin Quarry, left, Wrens, GA. Cision, PRWeb.com, Jan 23, 2018].
- Mined in 1700s as sources of white clay for Wedgwood pottery.
- Kaolin is mined along a belt located south of the Fall Line in the Georgia Coastal Plain (Prasad et al, 1991).
- The Kaolin units are enclosed in Coastal Plain sediments. These clastic sediments were weathered and transported from the Piedmont Plateau, Blue Ridge and Appalachian Mountains.

Economic Impact

- Georgia employs 8,200 mine workers, 38,000 jobs. Vast majority work in the kaolin industry.
- Georgia Kaolin is a sizeable industry having considerable impact on Georgia economy. 1-2B$/yr.
- 8 million tons kaolin mined each year.
- New uses include proppants and various paper coating products.

USG Chancellor Budget Request, January 22, 2019.

REE in GA Kaolins

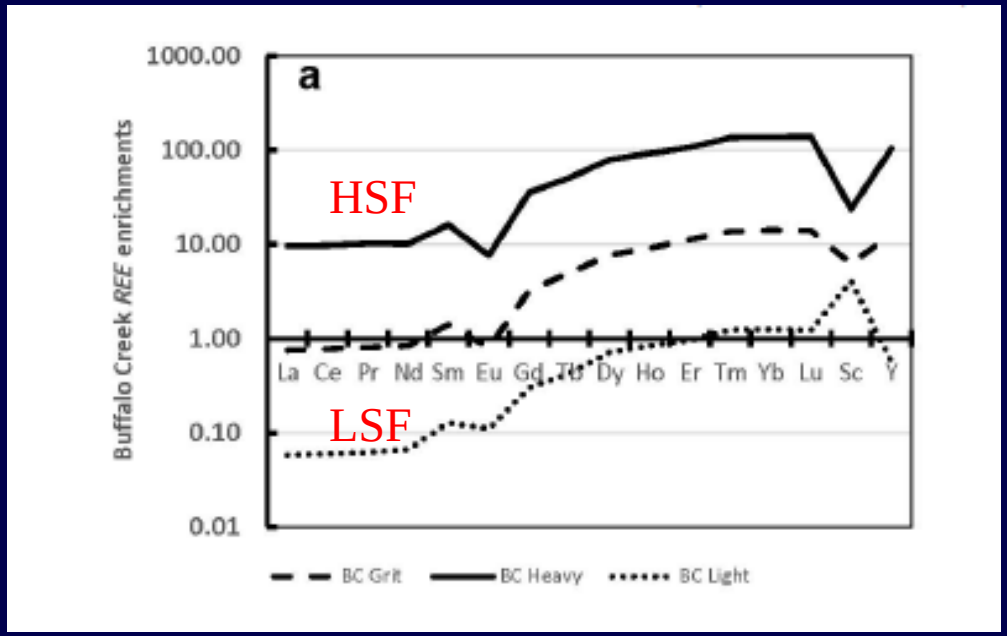
- Several earlier studies showed presence of specific REE (La, Nd). ~ 400 ppm (0.04 wt %). [Dombrowski 1993.]
- Cheshire (2011) and Cheshire et al, (2019) reported presence of REE-phosphates (LREE) in the clay fraction of mined kaolins and weathered bedrock (source of Coastal Plain sediments).
- A GSU study (Gardner thesis, and Elliott et al., 2018) noted large amounts of REE in the heavy subfraction of the grit/discarded fraction. [0.5 wt.%.].
- At that concentration, the heavy subfraction of grit is a novel resource for REE.
- The REE is found as trace constituents within zircon (Zr-silicate) and xenotime (Y-phosphate) in the mine waste.

Mine Waste from Kaolin Production

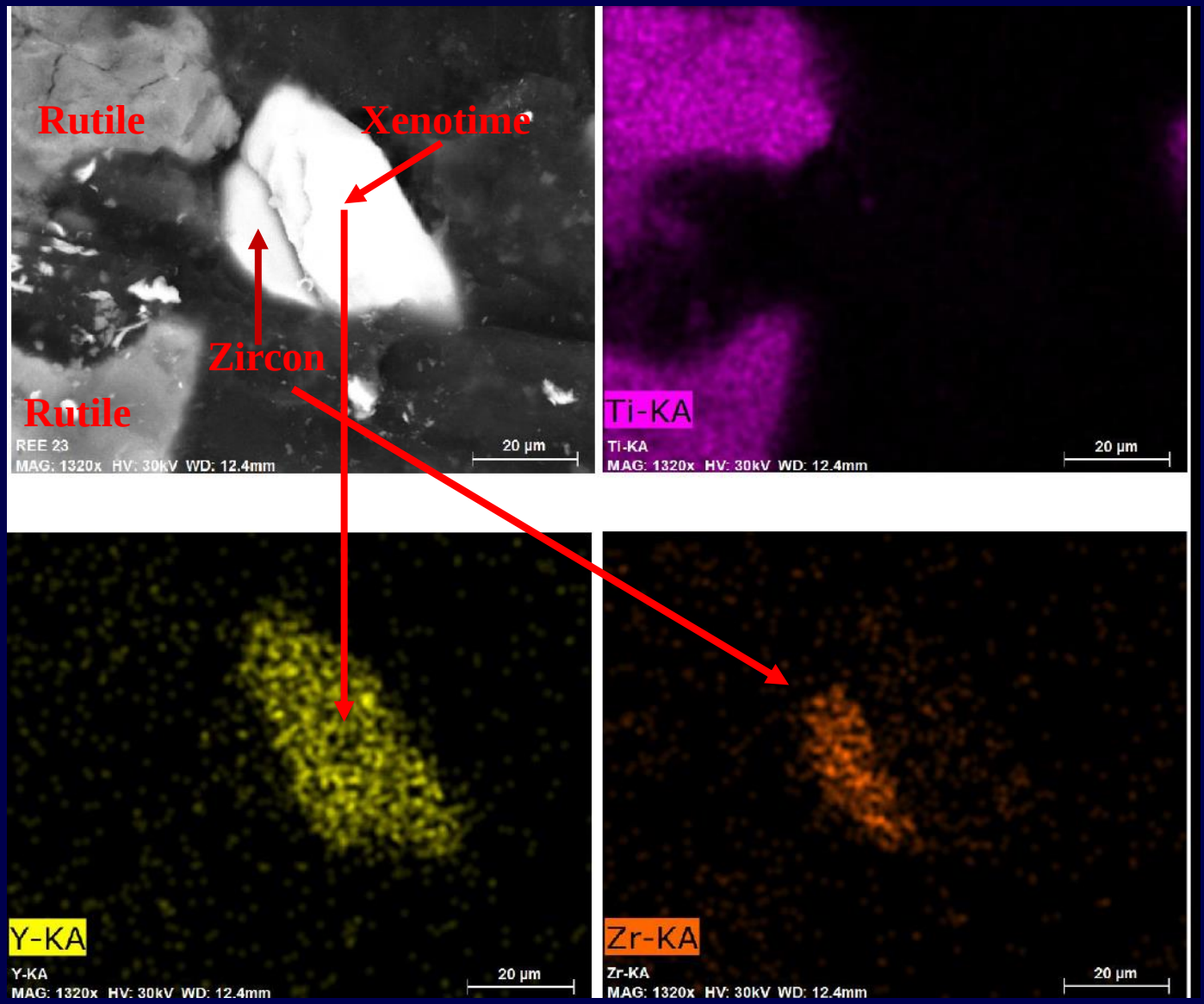
Key points.

- Approximately 10% of the mined kaolin is composed of silt-sand sized materials - *grit.*
- Grit is removed early from kaolin processing and discarded.
- REE are found most abundantly in the heavy mineral subfraction (HSF) of mine waste (Grit).
- The heavy subfraction of grit contained 0.11-0.5 wt.% REE.
- This HSF REE was enriched in the HREE (Y, Gd-Lu) relative to UCC by 10 and up to > 100 times.

REE conc. normalized to UCC.



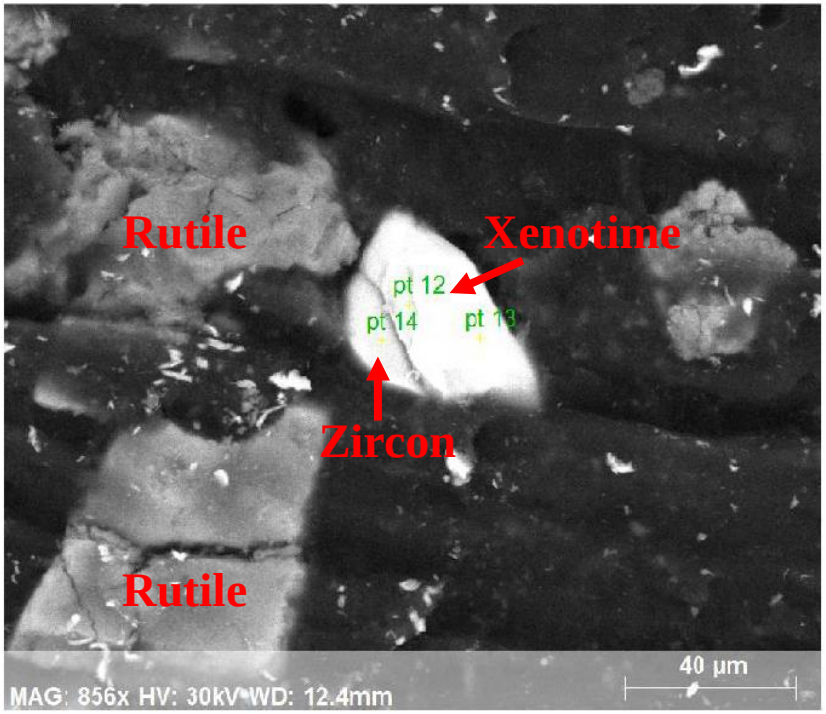
Scanning Electron Microscopy Analyses – Grit Minerals

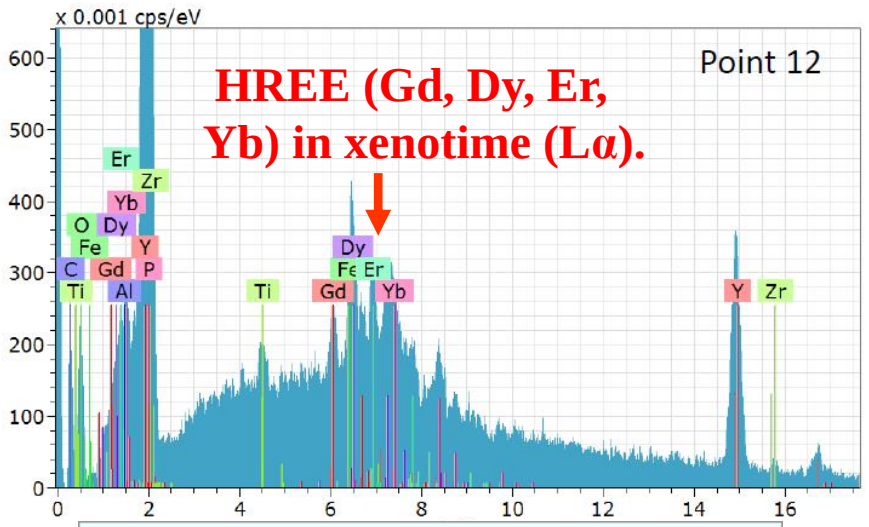


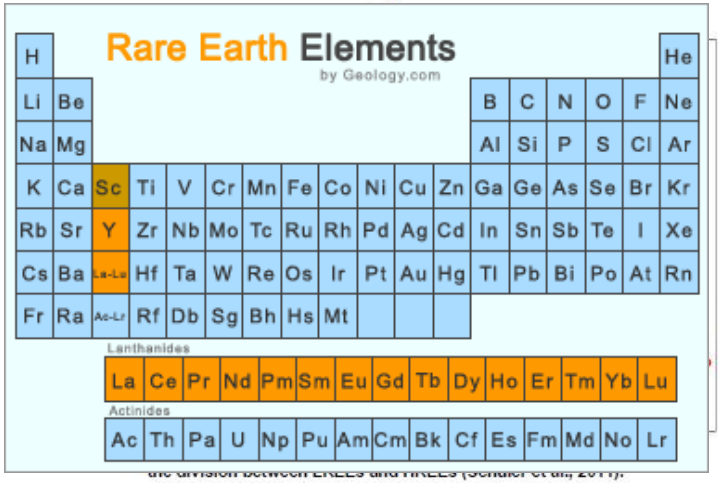
Rutile - TiO_2; Xenotime - YPO_4; Zircon - $ZrSiO_4$

Scanning Electron Microscopic Analyses

Point analysis of area 6-1







What did we learn?

- REE are found in grit minerals zircon and xenotime in GA kaolins.
- These phases were co-deposited with kaolin grains in forming the kaolin units presently being mined today.
- By chemical analyses, a heavy mineral subfraction of grit contains 0.5 wt. % REE (5,000 ppm REE).
- This heavy mineral subfraction is enriched in the heavy REE (Gd-Lu, Y) relative to crustal rocks. (Most crustal rocks are enriched in LREE).
- The occurrence of the REE in a heavy mineral subfraction from kaolin ore is a novel occurrence of the (H)REE in the US.

Final Remarks

Sizeable amounts of REE are found in a heavy mineral subfraction of kaolin mine waste. This subfraction is enriched in the HREE (rel. to UCC).

The REE are necessary and critical elements for many technologies (and we are dependent on international sources).

REE produced domestically at Mt Pass (CA) and Ti - Zr sand placers (GA).

The GSU work showed the REE can be coproduced in the process of mining kaolin by separating further the heavy fraction of kaolin mine waste.

Commercialization plans are ongoing.

Coproduction is a terrific lesson to teach - and we need to learn that lesson!

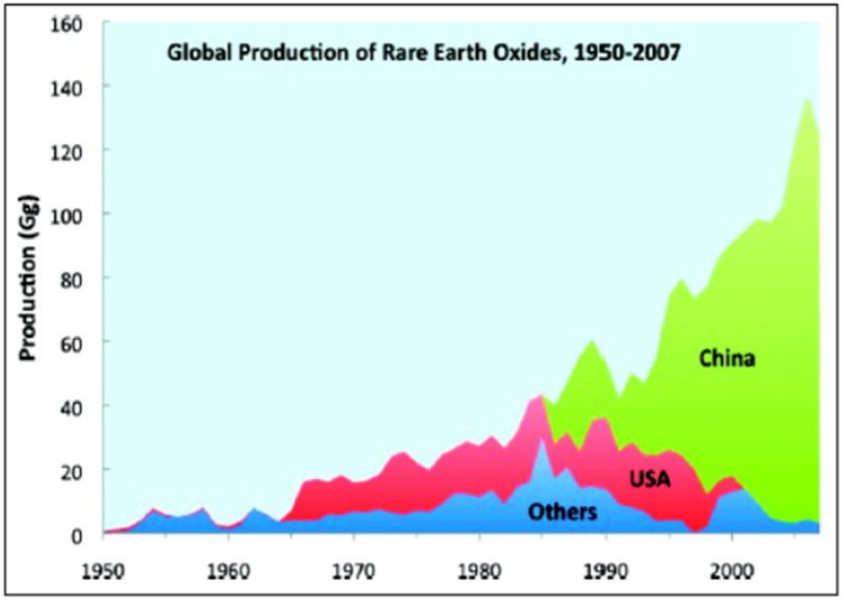


Figure 2-4. Global production of rare earth oxides (Du and Graedel, 2011).

THANK YOU!