Foundation Problems and Pyrite Oxidation in the Chattanooga (Ohio) Shale Estill County, Kentucky

John Kiefer, Kiefer@uky.edu
Warren H. Anderson, Wanderson@uky.edu
Kentucky Geological Survey
University of Kentucky
Project Location
DVGQ’s

• Digitally Vectorized Geologic Quadrangles
• Digital GQ data for the entire state
• Useful in Planning, Design, Construction and Remediation
Irvine DOQQ
Estill County Middle School
Black Shale Outcrop
Plan of Middle School
Stratigraphic Section
Foundation Problems in School
Tension fractures in retaining wall
Sulfate precipitates in drain tile
Iron Stain on Black Shale
Sulfate efflorescence on Shale
Cleats, fractures in subcrop
Copiapite along cleat
Pyrite nodule zone in Black Shale
Gymnasium Repair
Black Shale subcrop in School
Carhartt Factory
Foundation Problems in Factory
Heaved flooring adjacent to load bearing wall
Loading area
Marcum Wallace Hospital
Non-load bearing wall heaving
Repaired room adjacent to load bearing wall
Irvine Bypass built on Crab Orchard
Sulfates
Chemical Reaction

- $2\text{FeS}_2 + 3\text{H}_2\text{O} + \text{CaCO}_3 + 6\text{O}_2 \rightarrow \text{FeCa(SO}_4)+3\text{H}_2\text{SO}_4+\text{CO}_2+\text{Fe}$
- Pyrite, Water, Lime $\rightarrow$ Sulfate, Sulfuric Acid, Iron

- Iron Sulfates-Jarosite, Copiapite, Melanterite

- Water pH= 1-2 very acidic
X-Ray Diffractogram

- Iron Sulfates
- Quartz
- Clays
- B-1 14° 7
- B-2 3° 6
- B-3 3° 6
- B-4 3° 0
Stratigraphic position of buildings

Stratigraphic Location of Buildings
Examined in North Irvine Area.

- Marcum-Wallace Hospital
- Cannitt Factory
- Estill County Middle School
- State Route 499
- Crab Orchard Fm
Causes of Foundation Failure

- Oxidation of pyrite and growth of secondary sulfates in the shale.
- The shale degrades into various clay and sulfate minerals and has a lack of shear strength when subjected to loads.
- Parts of the school building and factory appear to be constructed on shale fill.
RECOMMENDATIONS

• Pre-construction prevention
• Remediation solutions
  – Remove foundation material and fill, and replace with impermeable water/moisture barrier. Create new sub-floor bearing walls or piers, and refill with non-shale aggregate
Future Work

• Statewide Geochemical Study of the Chattanooga (Ohio) shales to determine areas of high iron or pyrite content.
• Detailed work in the Estill County area to further define the high iron areas.
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BLACK SHALE PROBLEMS IN POWELL COUNTY
POWELL COUNTY – REAR CORNER OF HOUSE WAS PATCHED BECAUSE THE CISTERN BLEW UP. NATURAL GAS FROM THE SHALE WAS SEEING IN
POWELL COUNTY – YARD SLOPED DOWNWARD FROM ROAD ALLOWING WATER TO BUILD UP AGAINST HOUSE AND SEEP UNDERNEATH. NOTE CRACKS IN NEIGHBORS HOUSE.
Black Shale Problems

Road

fill

Wet Area

Black Shale
(Unstable-Pyrite, gas, radon)

fill

Second wall on floor

Patched cracks

KGS
Landslide-prone Areas of Kentucky

- Eastern Kentucky Coal Field
- Western Kentucky Coal Field
- Kope and Clays Ferry
- Crab Orchard
- New Albany and Borden
- Paragon
- Porters Creek Clay
- Bluffs along the Ohio and Mississippi