Non-Flood Geologic Hazards in Kentucky and Information Resources at the Kentucky Geological Survey

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Kentucky Association of Mitigation Managers
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Geologic Hazards:

We will examine the major three (in my opinion), in the order of your likelihood to encounter them (again, in my opinion): landslides, karst, earthquakes

- How do they work?
- Where do they happen?
- How to learn more…
Geologic Hazards in Kentucky
KGS Map and Chart 185
Landslides in Kentucky

Landslide inventory map of Kentucky
(as of 07/2012)

Location sources include geologic maps, KYTC, LiDAR, government agencies, the general public.
Landslides: highway hazard/maintenance issue
Landslides: gravity-dominated movement of material

any earth material: rocks, soil, or mix (“debris”)

style and rate of movement vary: fall, slide, or flow

Diagrams from USGS Landslide Hazards Program
Landslides: rates and distances vary

debris flows similar to “muddy” flash floods
creep is very slow and steady, can go unrecognised

Diagrams from USGS Landslide Hazards Program
Landslides: shales and steep slopes

shale can weather quickly to weak clay
steep slopes provide gravitational potential for landslides
**Landslides**: water is commonly responsible

- Heavy precipitation; flooding
- Poor drainage (can be structure specific)
- Utility leaks
- also: Shaking/vibration
  - Excavation (natural or manmade)
Landslides: Highway maintenance costs
Landslides: Highway maintenance costs

Average expected rockfall maintenance costs per mile per year by geologic unit.

Average expected landslide/sinkhole maintenance costs per mile per year by geologic unit.
Landslides:
KyTC Highway District Maps

For each of the 12 districts, the rockfall, landslide/sinkhole geology relationship illustrated
Karst: dissolution of solid rock

dissolution of soluble rock
sinkholes, caves, springs
...underground plumbing system
susceptible to sinkhole collapse, flooding, contaminant transport
Kentucky Karst Potential

Karst is an issue for much of Commonwealth

Karst occurrence in Kentucky

Paylor and Currens (2001)
KGS Map and Chart 33
Karst along Gene Snyder Expressway

solution features in limestone
Karst: Cover-collapse sinkhole

soil and regolith fall into underground system
Karst: Cover collapse sinkhole

*Can cause significant structural damage, typically localized*
Karst: Sinkhole flooding

Blockage/modification of underground drainage can cause “unpredictable” surface flooding
Earthquakes

release of energy when rocks break under natural stress
hypocenter is where break starts; rupture does not always “daylight” to surface
epicenter is projection of hypocenter to earth’s surface
Earthquakes typically occur along boundaries of tectonic plates.
Earthquakes

intra-plate earthquakes are an issue in the central U.S.

From USGS National Earthquake Information Center: August 26, 2013
Earthquakes: site characteristics can amplify ground motion
depends on type and thickness of material
Earthquakes: Ohio River Valley

variable materials and depth to bedrock
related to Pleistocene ("Ice Age") events, processes, and deposits
Magnitude / Intensity Comparison
The following table gives intensities that are typically observed at locations near the epicenter of earthquakes of different magnitudes.

Abbreviated Modified Mercalli Intensity Scale
I. Not felt except by a very few under especially favorable conditions.
II. Felt only by a few persons at rest, especially on upper floors of buildings.
III. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
IV. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V. Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI. Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII. Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
XI. Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
XII. Damage total. Lines of sight and level are distorted. Objects thrown into the air.

From USGS
Kentucky: Earthquake experiences

**Illinois**

M5.4

2008 April 18

Louisville II-V

![USGS Community Internet Intensity Map](image)
Calamity!

Catastrophe!

Apocalypse!

No... wait, it's just a few bricks on the sidewalk...
Kentucky: Earthquake experiences

Sharpsburg KY
M5.2, MMI VII
1980 July 27
Illinois
M5.4, MMI VII
1968 Nov 09

Kentucky: Earthquake experiences
Kentucky: Earthquake experiences

Charleston MO
M6.6, MMI VIII
1895 October 31
Kentucky: Earthquake experiences

New Madrid MO
M7.7 (USGS), MMI XI
1811-1812 (4eqs)
"On Monday morning the 16th instant, this place was visited by a **most alarming** Earthquake. . . . We are induced to believe, the continuation was from 4 to 6 minutes, though some say it was not so long; -- about an hour afterwards, another shock was felt; and a little after sunrise, a third, **which broke off several chimneys, and injured some houses otherwise.**"

(Poulson's American Daily Advertiser, Philadelphia, Pa.).
Ground Motion for the Maximum Credible Earthquake in Kentucky
Zhenming Wang (2010)
KGS Report of Investigations 22
Disclaimer

no geologists were harmed during the development of this presentation
Questions?

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KGS Mapping Mission

Develop detailed (1:24,000-scale) geologic maps for the Commonwealth of Kentucky that are suitable for

- delineating geologic hazards,
- developing economic resources,
- understanding groundwater flow and quality,
- geotechnical and land-use planning,
- and other soil and landscape related activities.
Criteria determined by KSGMAC:

- **population centers**: focusing on areas of higher population that do not have adequate surficial mapping;

- **land use**: areas of high industrial or residential development have already experienced significant disturbance and are not practical mapping targets;

- **major transportation corridors**: future development is most likely to occur along major transportation corridors such as Interstate highways;

- **geologic hazards already identified in a quadrangle**: areas that have experienced significant landslide activity in the past are most likely to experience future landslide issues;

- **also**: Energy Site Bank, population growth/change, are factors to qualify/disqualify a quad for mapping
Your turn…

- Areas that need better mapping?
- Areas likely to experience growth?
- Adjusting the criteria for prioritizing?
- GIS resources to illustrate the priorities?