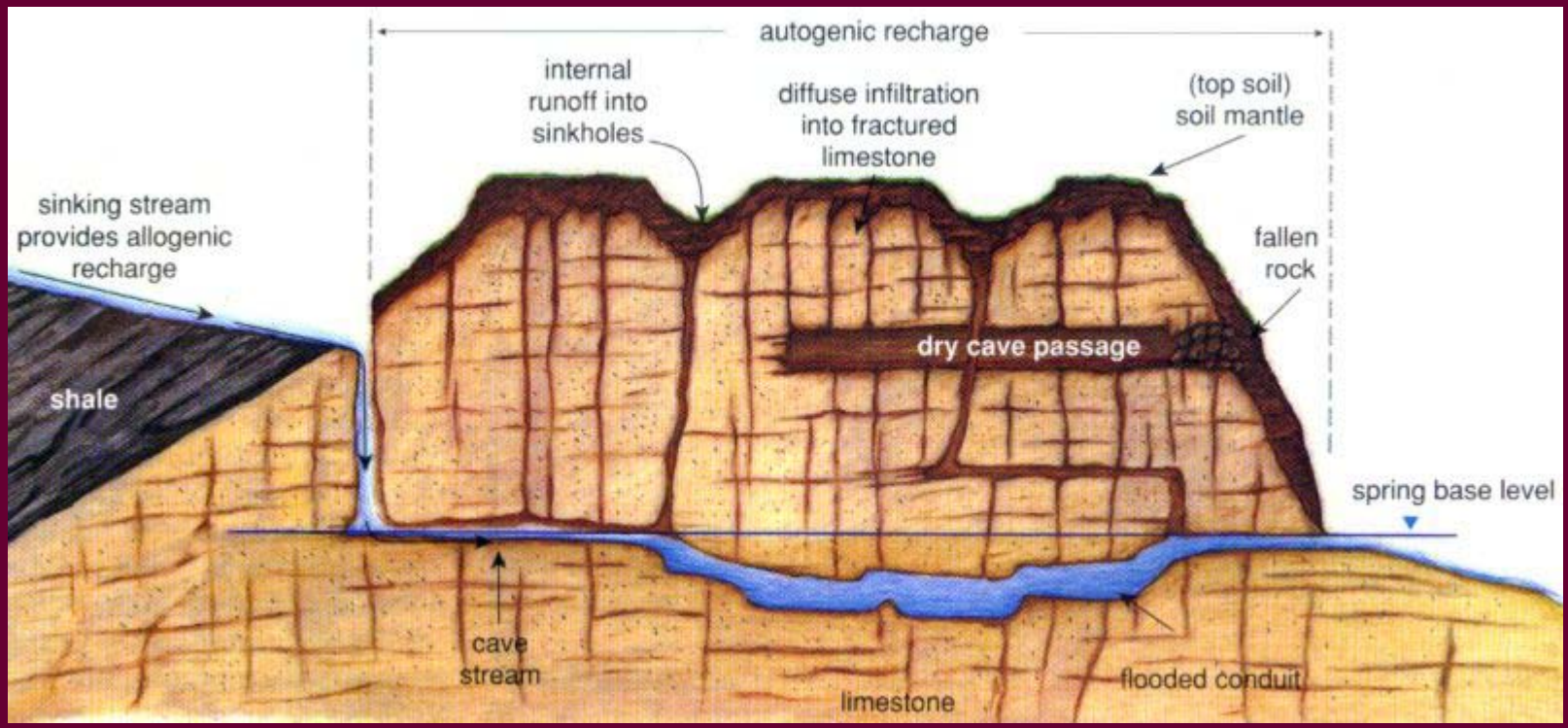
Introduction to Virginia's Karst

A presentation of
The Virginia Department of
Conservation and Recreation's
Karst Program & Project Underground

Karst - A landscape developed in limestone, dolomite, marble, or other soluble rocks and characterized by subsurface drainage systems, sinking or losing streams, sinkholes, springs, and caves.



Cross-section diagram by David Culver, American University.

Caves & Karst of Virginia

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1995

Karst topography covers much of the Valley and Ridge Province in the western third of the state.

Aerial photo of karst landscape in Russell County.

Smaller karst areas also occur in the Cumberland Plateau, Piedmont, and Coastal Plain provinces. At least 29 counties support karst terrane in western Virginia.

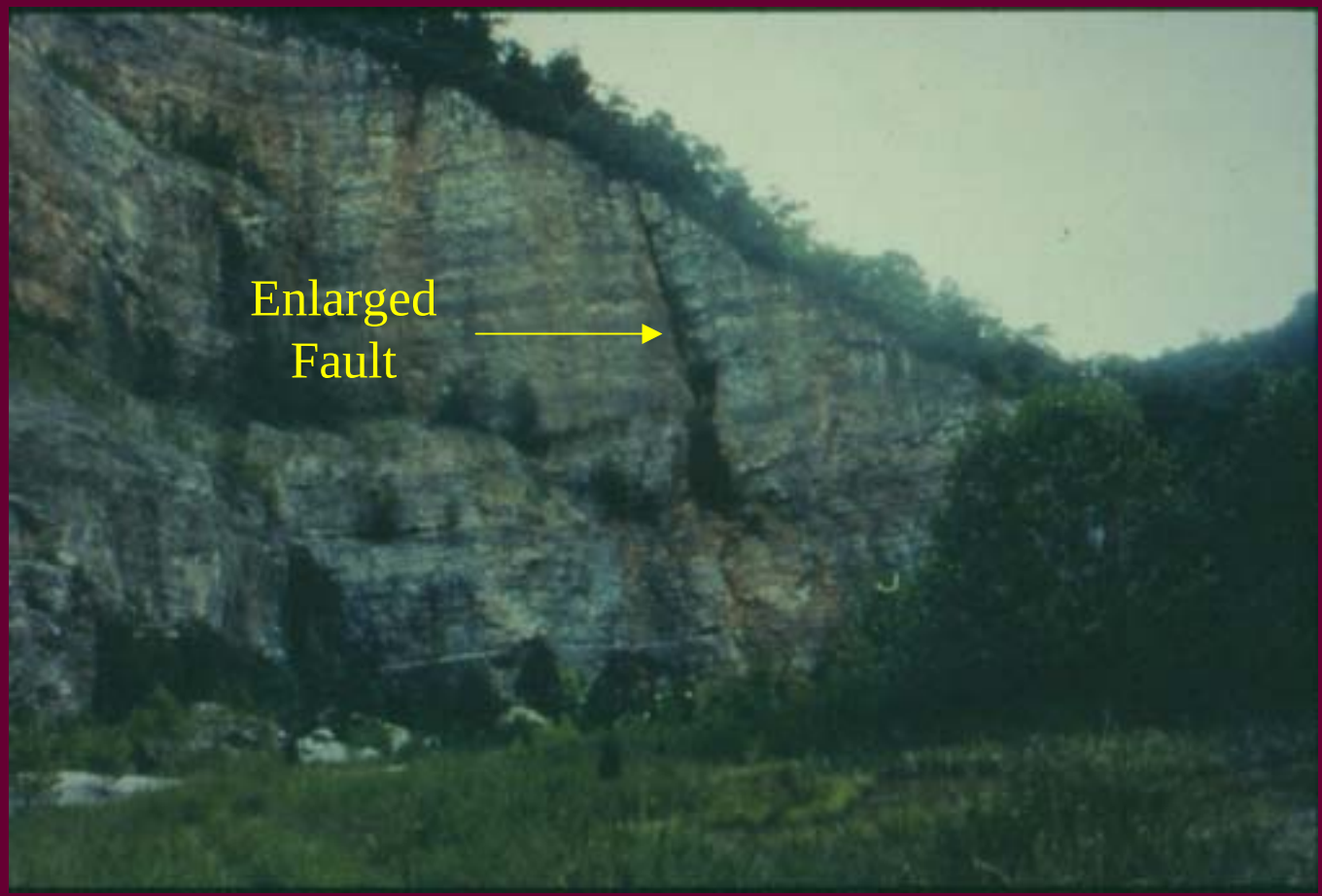
In western Virginia, karst occurs along slopes and in valleys between mountain ridges. There are few surface streams in these limestone valleys as runoff from mountain slopes disappears into the subsurface upon contact with the karst bedrock. Water flows underground, emerging at springs on the valley floor.

Thin soils over fractured, cavernous limestone allow precipitation to enter the subsurface directly and rapidly, with a minimal amount of natural filtration.

The purer the limestone, the less soil develops on the bedrock, leaving bare pinnacles exposed at the ground surface. Rock pinnacles may also occur where land use practices result in massive soil loss.

Precipitation mixing with carbon dioxide becomes acidic as it passes through soil. Through geologic time slightly acidic water dissolves and enlarges the bedrock fractures, forming caves and other voids in the bedrock.

Water follows the path of least resistance, so it moves through voids in rock layers, fractures, and boundaries between soluble and insoluble bedrock.



Fault (shear fracture) enlarged by movement of water.

Sinkhole – A general term for closed depressions. Sinkholes form by the removal and collapse of surface material into underlying voids. Sinkholes are one of the most obvious indicators of a karst terrane.

Sinkholes can form in a line, following underground paths that lie below the surface.

A karst window is formed when the roof of a cave collapses or is eroded away exposing the water table. These features present a direct avenue for surface pollutants to come in contact with groundwater.

Sinking Stream -A direct way for surface water to become groundwater is by the capture of surface streams into subsurface voids through swallets. These features “swallow” the surface stream and represent a rapid and direct avenue for groundwater recharge.

Losing Streams – Streams in karst terrane may lose large volumes of surface water through a gradual loss into underground caverns. Here fluorescent dye is introduced to trace the course of the North River, a losing stream under drought conditions.

Swallet Holes

Runoff from a cow pasture enters an actively collapsing sinkhole where channelized water sinks into the ground. Such sinkholes, sometimes called swallet holes, provide a direct connection between surface water and groundwater.

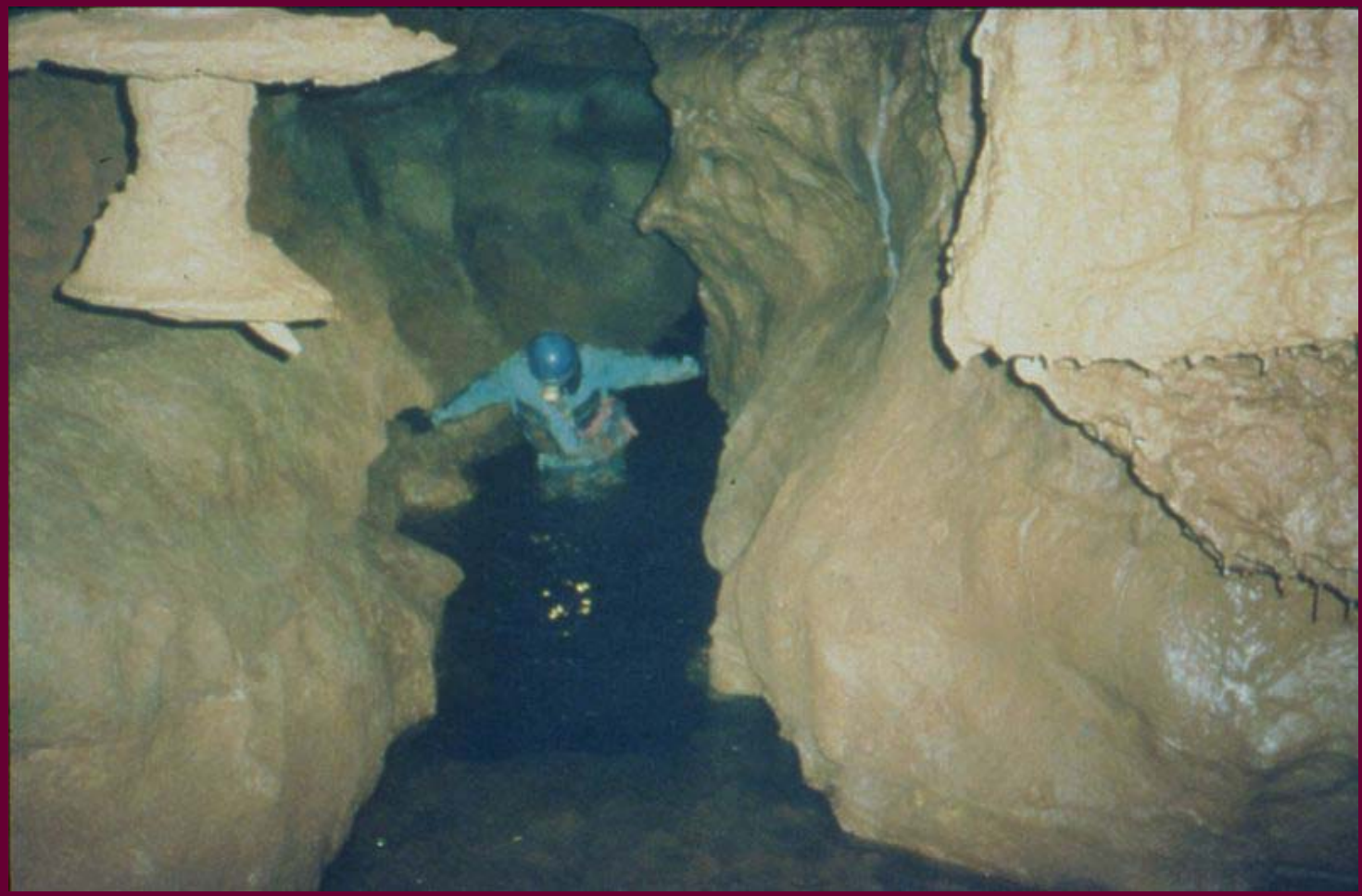
Karst Dye Trace – Investigators use nontoxic, fluorescent dyes to chart the course of underground streams.

Fluorescein die is introduced upstream of a western Virginia swallet.

If one were to follow the course of surface water flowing into holes in the ground it would lead through a vertical conduit to the cavernous reservoir system below.

Water drips through cave roofs forming waterfalls and pools. Mineral-laden water deposits delicate calcite formations as it flows down cave walls and floors.

Water flows along the sculpted cave floor like a surface stream. Karst groundwater moves rapidly, up to several miles a day.



Most karst groundwater returns to the surface at springs near streams and rivers. Karst springs may be important sources of clean groundwater discharging to Virginia streams and rivers.

Powell River Spring in Wise County.

Many karst springs are used as water supplies, both public and private.

McKay Spring in Warren County.

Environmental Sensitivity of Karst

- Contaminants can enter the karst groundwater quickly, with little or no filtration, through
  - Sinkholes
  - Sinking or losing streams
  - Bedrock fissures enlarged by dissolution
- Once underground
  - Water flows at high rates (10's of meters to kilometers per day)
  - Water follows difficult to predict paths, bearing little relationship to surface topography

There are many threats to groundwater quality and cave habitats in karst areas. Here soil erosion, a form of nonpoint source pollution, leaves bare soil to wash into streams and sinkholes and eventually into caves and groundwater.

Cows in the Creek – Livestock tend to gather at the watering hole, which contributes large amounts of manure and sediment to the stream. When this is a sinking stream, those pollutants may be directly introduced to the karst aquifer and water supplies!

Sinking Stream → Underground River → Karst Spring → Water Supply

Sinkhole Dumps - The fastest way to pollute your well or spring is to dump dead animals, chemical, and other wastes into sinkholes.

This is a concern because sinkholes are locations of concentrated discharge into the underlying karst aquifer!

Alterations to surface hydrology during agricultural, residential, or industrial development can cause the formation of sinkholes. Storm water runoff from parking lots and roads can carry petroleum, salts, sediment, and metals into groundwater supplies.

Some karst areas show no visible signs of cavern development, yet sinkholes can suddenly form due to changes in water use or drainage areas. The flood plain of the Shenandoah River is located over a flooded cave system, tapped by public water supply wells.

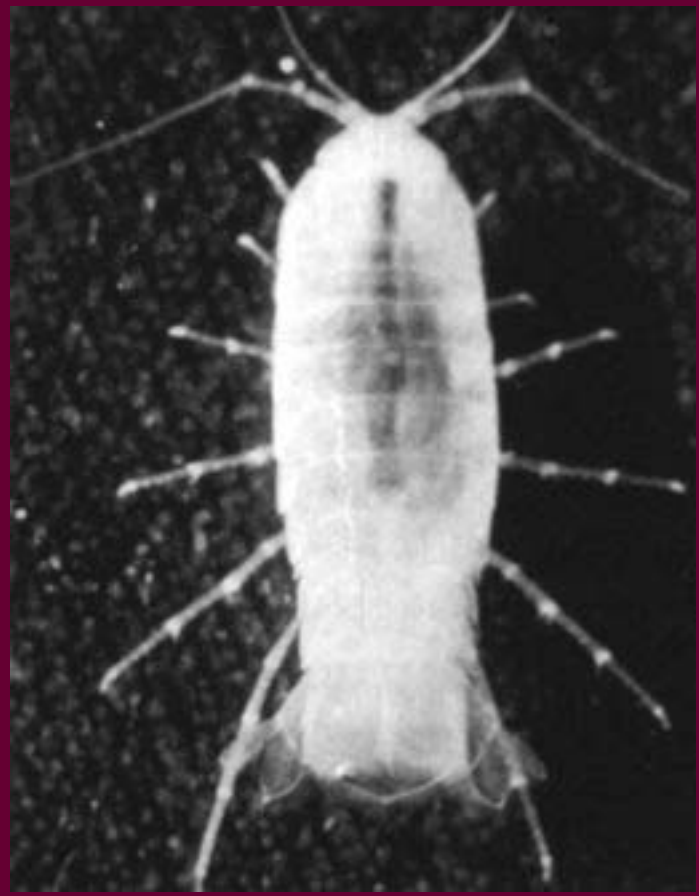
This is one of the most dramatic cases of sinkhole subsidence in recent years. This home was lost when a new well was drilled and over-pumped, rapidly pulling down the water table that apparently supported the cave roof below the house.

Failing septic systems can contaminate karst groundwater. Here a septic tank is falling into the underlying cave system, which is not an uncommon problem in karst areas.

Caves and karst areas can be a problem for road construction. Today new road projects avoid known caves whenever possible.

Biodiversity in Karst

- Animals have developed highly specialized adaptations to survive underground.
- Karst aquifers provide important habitat for many rare, threatened, or endangered animals.
- At least 8 bat species use Virginia's cave habitat
- Many cave species are known from only one or a few caves.



Antrolana lira – Madison Cave Isopod

Caves are the primary water carriers in karst country, and also provide essential habitat for rare and threatened species. In Virginia, certain caves are designated as being significant, and are protected for their specific hydrologic, biologic, archaeological and many other values. For more information on caves and karst, please contact DCR's Division of Natural Heritage and the Virginia Cave Board.

A karst landscape

Sinkholes

Water trickling into a cave entrance.

Cave passage

Flowstone - the pure white color is due to the mineral calcite, dissolved from overlying rock and then deposited in the cave from the mineral-laden groundwater.

Stalactites, stalagmites, and flowstone receive their colors from iron and other impurities in the water.