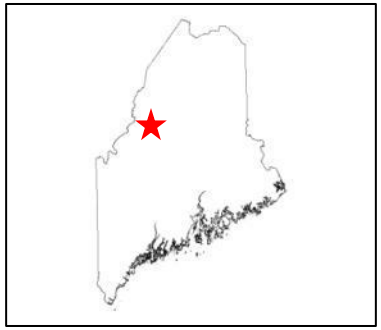
Maine Geologic Facts and Localities

February, 2007

Maine's Enchanted Cave



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Maine Caves

Maine caves are generally categorized as sea caves, talus/fissure caves, and solution caves. Sea caves form along zones of weakness in the rock which may include areas of cracks or where there are differences in abrasive resistance. Since the action of waves is concentrated at the base of cliffs, an overhang forms (Figure 1). The Ovens of Mount Desert Island are examples of Maine sea caves.

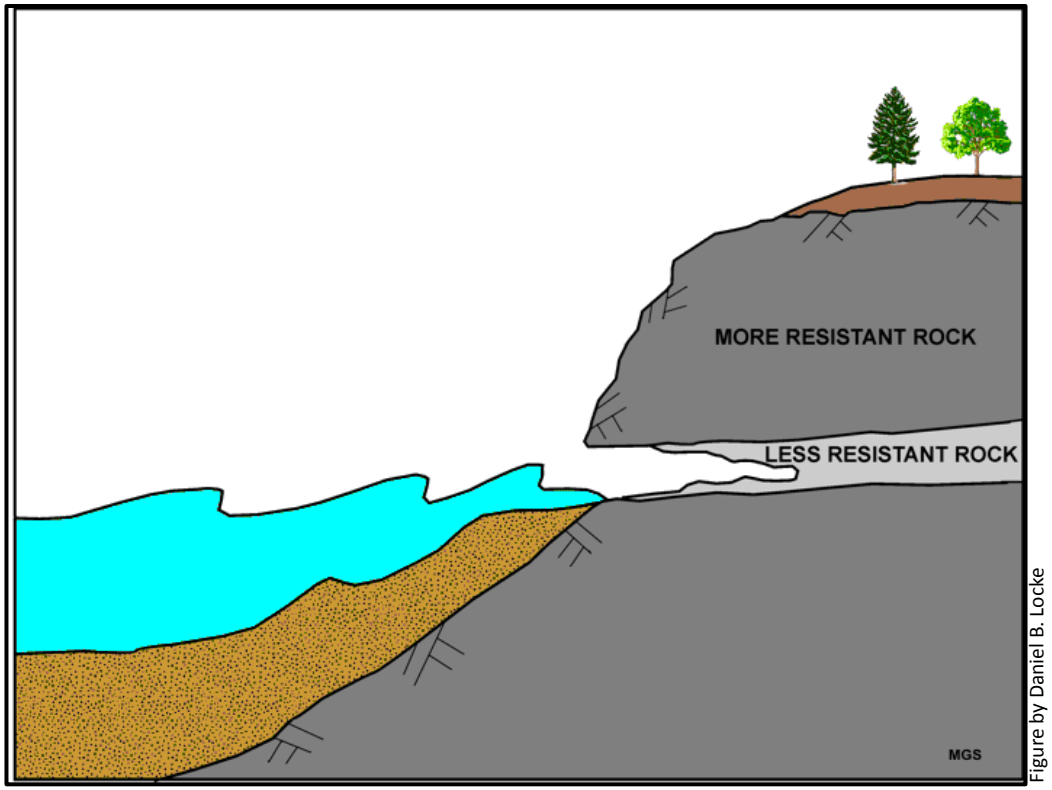

Figure 1. Sea caves created by wave action along zones of weakness in the rock.

Maine Caves

Talus or fissure caves are typically found in various types of granite and are caused by large slabs of rock and boulders which have shifted as a result of slides and collapses (Figure 2). An example of a Maine talus cave includes the Allagash Ice Cave which is noted for being the longest of its type in New England.

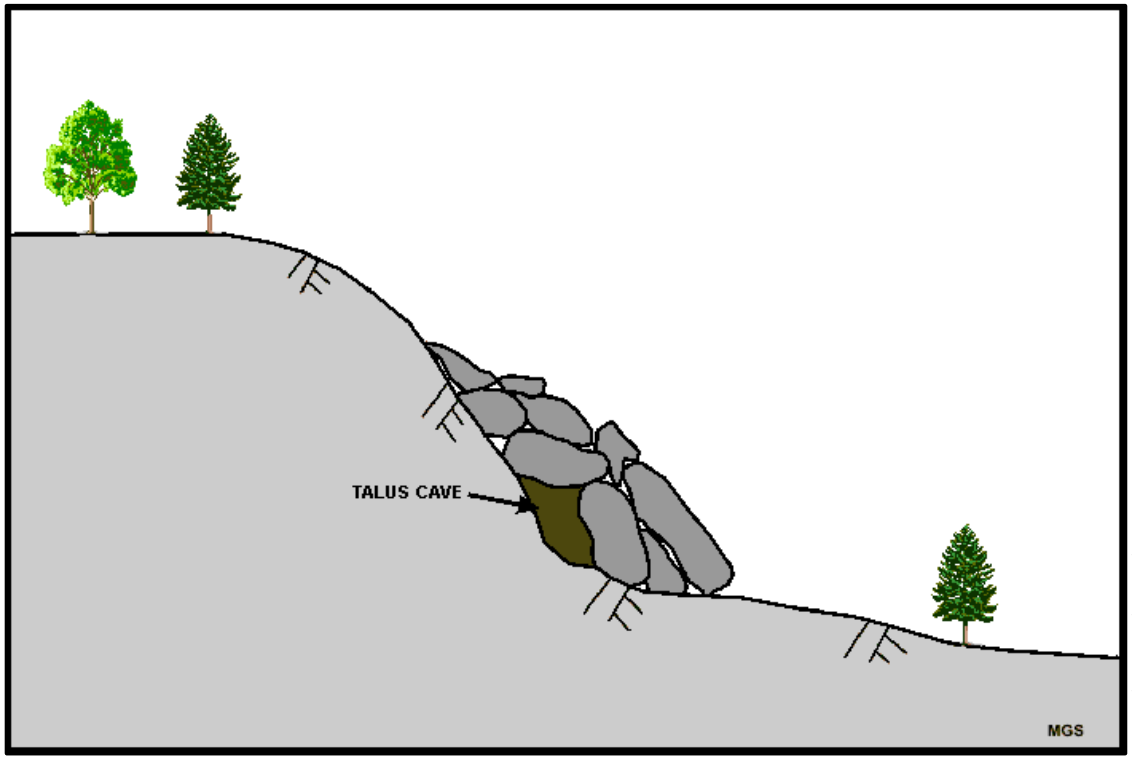

Figure 2. Talus cave formed by the collapse of large slabs of rock.

Maine Caves

Solution caves in Maine are formed in carbonate rocks, such as limestone and marble, by the action of moving water. Water seeps through soil and fractures in the underlying bedrock where it eventually reaches the water table. As the water table naturally lowers, carbonic acid contained in the water dissolves minerals such as calcite, the major constituent in limestone. This process in turn forms tunnels, irregular passages, and large solution caverns (Figure 3). Solution caves are perhaps the best known of these cave types and are made famous by such sites as Mammoth Caves in Kentucky, Carlsbad Caverns in New Mexico, and the Luray Caverns of Virginia. The Enchanted Cave of northwestern Maine is also classified as a solution cave and is the subject of this webpage.

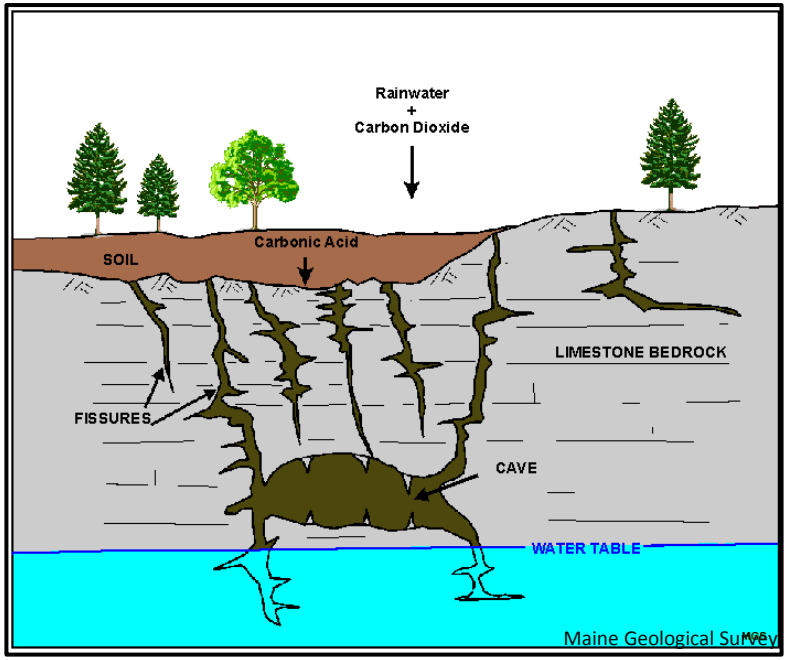

Figure by Daniel B. Locke

Figure 3. Solution cave formed in carbonate rock by action of moving water.

Enchanted Cave

Enchanted Cave is in a small band of limestone rock in northwestern Maine, within the Devonian Tarratine Formation. Solution caves such as this are not common in Maine and are known to occur in only three localities. Areas where conditions support the formation of such caves typically exhibit absent or reduced surface water drainage and a rocky, barren landscape and are referred to as having a karst landscape.

The processes involved in the creation of Enchanted Cave, as well as other similar limestone solution caves, involve rain which picks up carbon dioxide as it falls through the atmosphere. As this precipitation percolates through the soil, more carbon dioxide from plant roots and decaying vegetative matter becomes dissolved in the water to form a weak acid, carbonic acid, as well as complex organic acids called humic acids. This ground water can readily dissolve limestone, creating erosional features in the rock. As water levels are lowered to leave open fissures and caves, dissolved calcium carbonate may precipitate to form beautiful dripstone features known as speleothems. These depositional features form above the water table.

Simplified Chemical Reactions

The formation of a weak acid

H_20	+	CO_2	→	H_2CO_3
water (liquid)		*carbon dioxide (gas)*	*form*	*carbonic acid (dissolved in water)*

The dissolution of limestone

$CaCO_3$	+	H_2CO_3	↔	Ca^{2+}	+	$2(HCO_3)^-$
calcium carbonate (solid)		*carbonic acid (dissolved)*	*form*	*calcium ions (dissolved)*		*bicarbonate ions (dissolved)*

The precipitation of calcite

Ca^{2+}	+	$2(HCO_3)^-$	↔	$CaCO_3$	+	CO_2	+	H_2O
calcium Ions (dissolved)		*bicarbonate ions (dissolved)*	*form*	*calcium carbonate (solid)*		*carbon dioxide (gas)*		*water (liquid)*

Enchanted Cave

Two of the most common speleothems include stalactites and stalagmites. Stalactites hang downward from the ceiling and are formed as drop after drop of water with dissolved calcium and bicarbonate ions slowly trickles through cracks in the cave roof. As carbon dioxide is released to the atmosphere and water evaporated, a residue of calcium carbonate is deposited. Stalagmites grow upward from the floor of the cave generally as a result of water dripping from overhanging stalactites.

Although stalagmites have not been observed in the 140 meter expanse of Enchanted Cave, the following gallery of photographs should provide a glimpse into this very "enchanted" place.

Entrances to Enchanted Cave

Maine caves are protected by law, according to the Maine Cave Protection Act, which grants specific landowner rights as well as prohibiting activities which detract from the natural, historical, and archaeological value of caves.

Photo by William D. O'Brien and Jason G. Choquette

Figure 4. North entrance to the Enchanted Cave.

Entrances to Enchanted Cave

Photo by William D. O'Brien and Jason G. Choquette

Figure 5. South entrance to Enchanted Cave. Notice how the crevices tend to follow the layers in the limestone.

Erosional Features

Photos by William D. O'Brien and Jason G. Choquette

Figure 6. Examples of relatively smooth erosional features where water has dissolved the limestone in Enchanted Cave.

Erosional Features

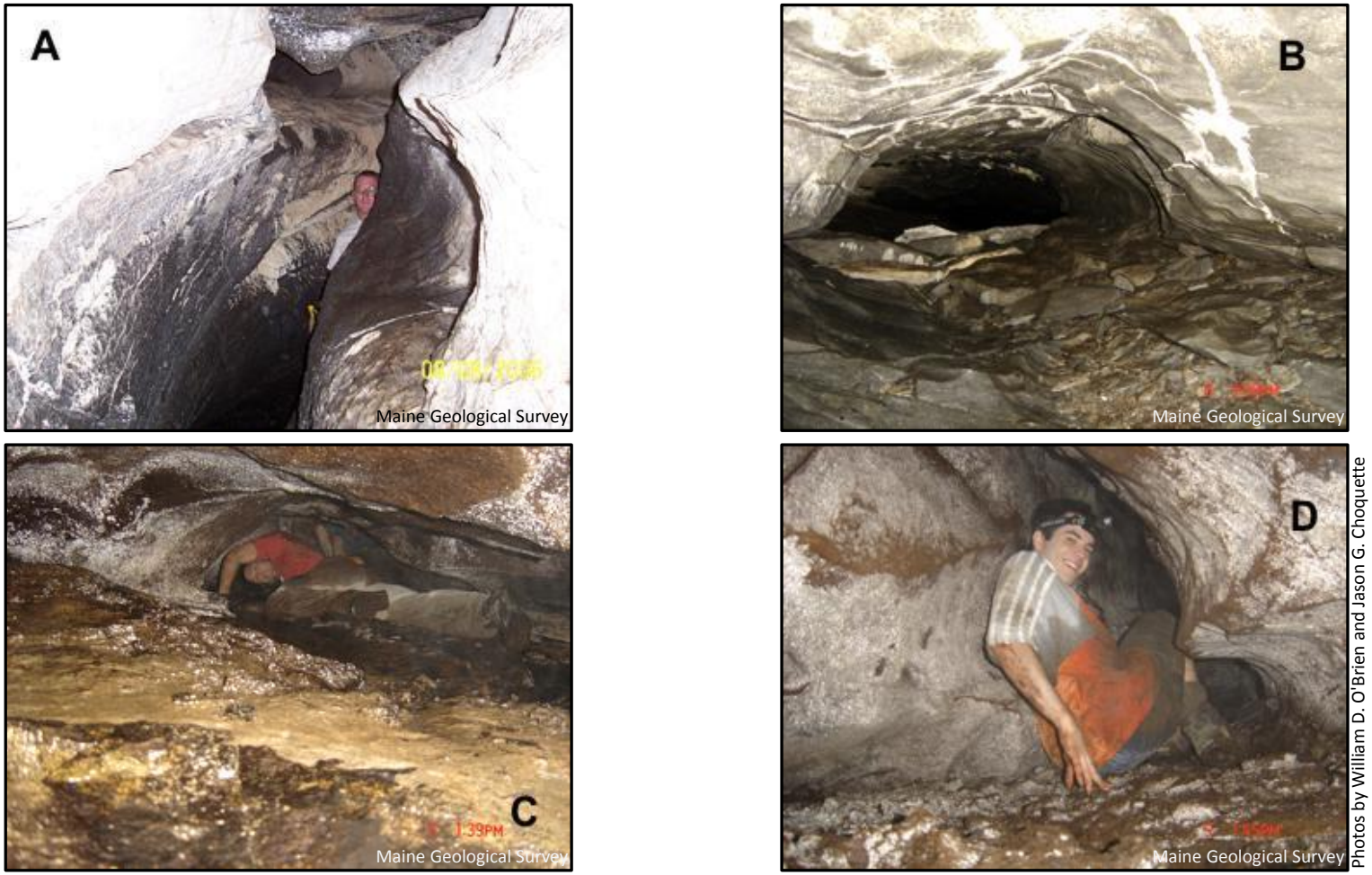

Figure 7. Smoother passageways in Enchanted Cave. A) Example of the many meandering S-turns. B) Rounded walls and ceiling over a rubble-covered floor. C) Exploring one of the passageways. D) The caver was forced to be a contortionist in order to proceed.

Erosional Features

Figure 8. A) Angular passageway. B) Some of the passageways exhibited both rounded and angular features. C) Some of the passageways are relatively flat following layers in the rock. In this very flat passageway, movement is limited to crawling and squeezing.

Erosional Features

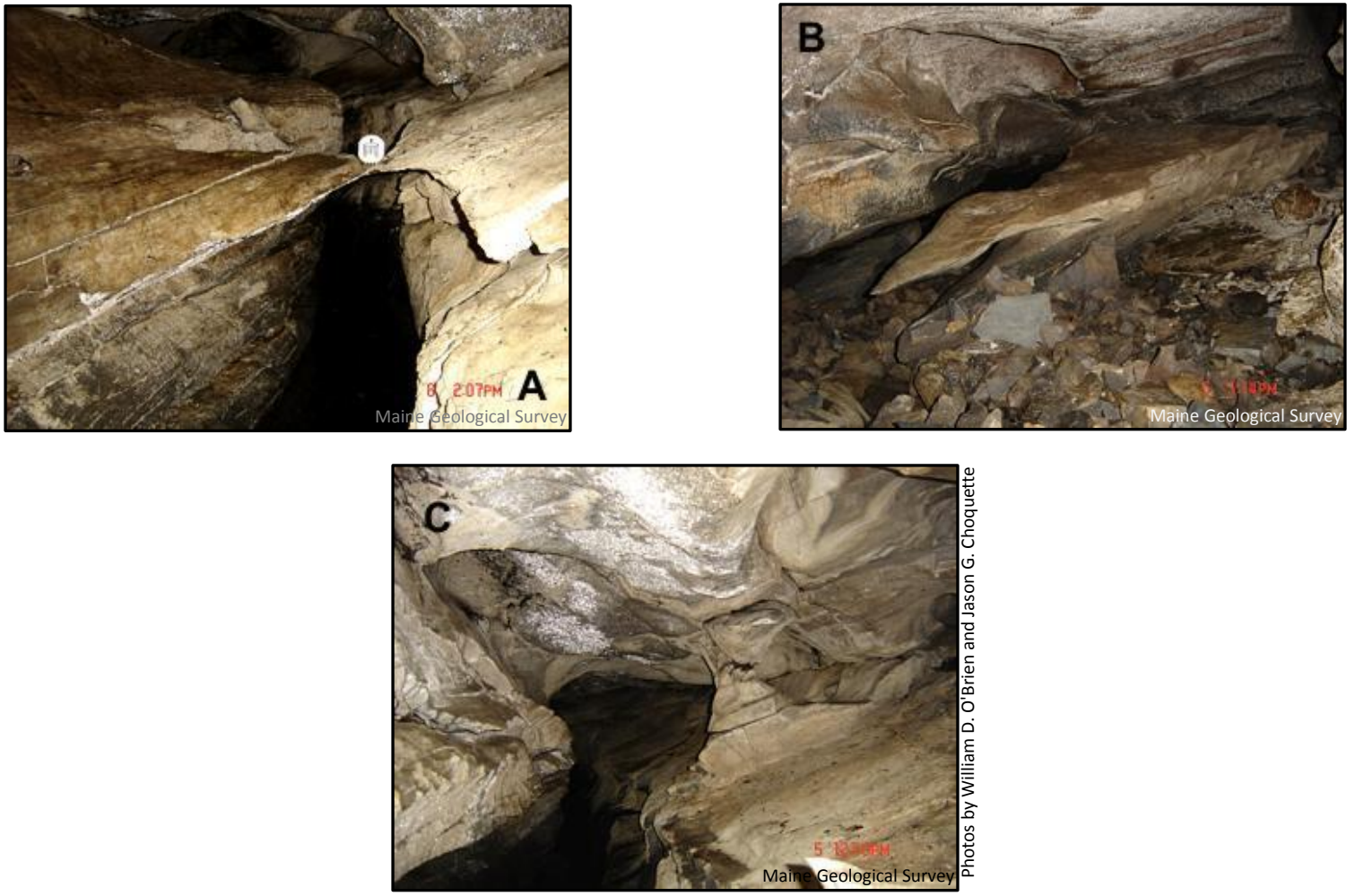

Figure 9. Smaller erosional features. A) Bridge-like erosional feature with precariously balanced Brunton compass shown for scale. B) Long table-like erosional feature. C) Small pillar.

Depositional Features

Photos by William D. O'Brien and Jason G. Choquette

Figure 10. These speleothems, which are related to stalactites in the way they form, occur as "curtains" or "draperies" along the ceiling and wall.

Depositional Features

Photo by William D. O'Brien and Jason G. Choquette

Figure 11. Examples of very small stalactites. These are referred to as "soda straws" if they are hollow.

Depositional Features

Photos by William D. O'Brien and Jason G. Choquette

Figure 12. A) This passageway allows semi-upright movement. Note the snake or worm-like growths of calcium carbonate along the cave wall to the right. B) Close-up of worm- or twig-shaped speleothems.

Fossils

Photos by William D. O'Brien and Jason G. Choquette

Figure 13. Small, white shell fragments within the limestone rock.

References and Additional Information

Information on caves, caving, and safety issues:

- U. S. Geological Survey - use search engine to find information and teacher packets
- National Speleological Society
- Boston Grotto
- Maine Caves

Solution cave formation:

- National Caves Association
- Exploring Earth ES1405: Observe an animation of cave formation