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Gila Cliff Dwellings National Monument

Southwestern New Mexico

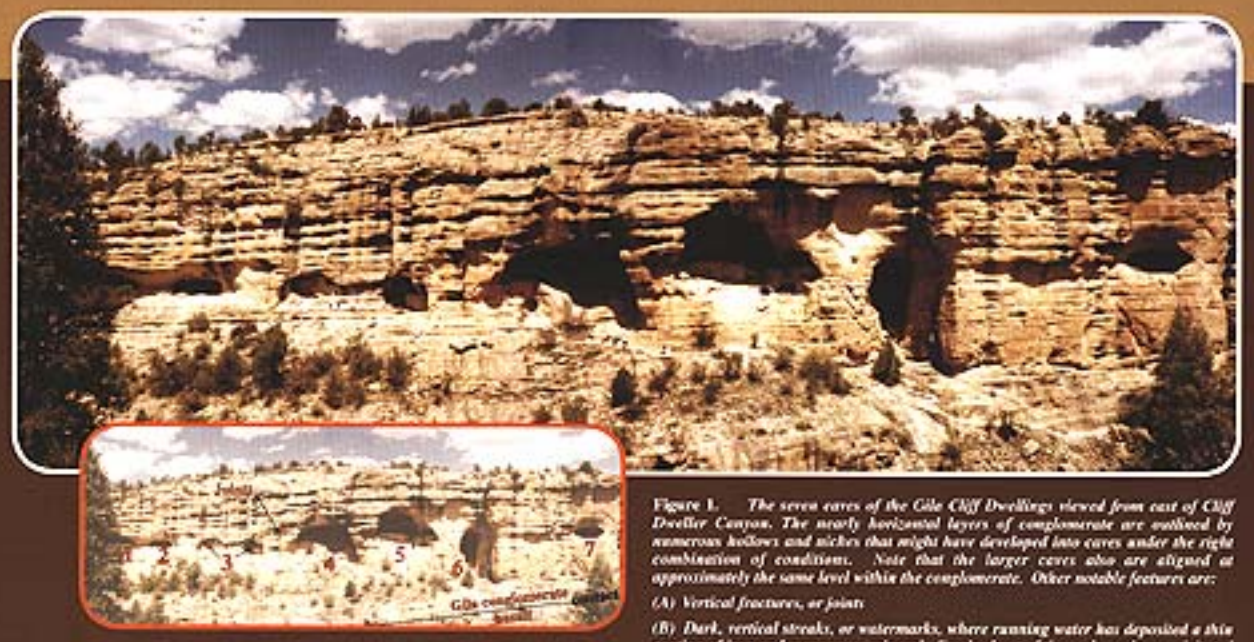


Figure 1. The seven caves of the Gila Cliff Dwellings viewed from east of Cliff Dweller Canyon. The nearly horizontal layers of conglomerate are outlined by numerous hollows and niches that might have developed into caves under the right combination of conditions. Note that the larger caves also are aligned at approximately the same level within the conglomerate. Other notable features are:

(A) Vertical fractures, or joints

(B) Dark, vertical streaks, or watermarks, where running water has deposited a thin coating of iron and manganese minerals dissolved out of the rocks and reprecipitated from solution as the water ran down the cliffs

(C) A contact between the Gila conglomerate and the underlying basaltic lava flows upon which the conglomerate was deposited.

Origin and Development of the Caves

The caves were probably excavated originally by a combination of *stream action* and *spring sapping*. As the stream in Cliff Dweller Canyon cut down through the layers of Gila conglomerate, it may have encountered a relatively soft layer and cut laterally into it, initiating an alcove similar to the alcove presently being formed near the bridge at STOP NO. 5 along the trail in the canyon (see Figure 2). This alcove is being formed at the *contact* between Gila conglomerate and the harder, underlying basaltic lava flows. Note that caves 1–7 at the cliff dwellings are all at about the same level in the Gila conglomerate (see Figure 1).

Lateral stream erosion is most effective where bends cause the stream to impinge directly on the canyon walls. *Spring sapping*, or sapping, is a natural erosion process, usually at the base of a cliff. Softer layers are worn away, leaving upper layers unsupported, which break off in large and small blocks. It may work in conjunction with lateral stream erosion, or may be the main process in cave formation.

Figure 2. An alcove has developed near the bridge across Cliff Dweller Canyon near STOP 5 along the canyon trail. The alcove is the result of erosion along the contact between the more resistant basaltic lava beneath and the more easily eroded Gila conglomerate above. Erosion of the alcove has probably been by lateral cutting of the stream in Cliff Dweller Canyon, by spring sapping, or a combination of the two processes.

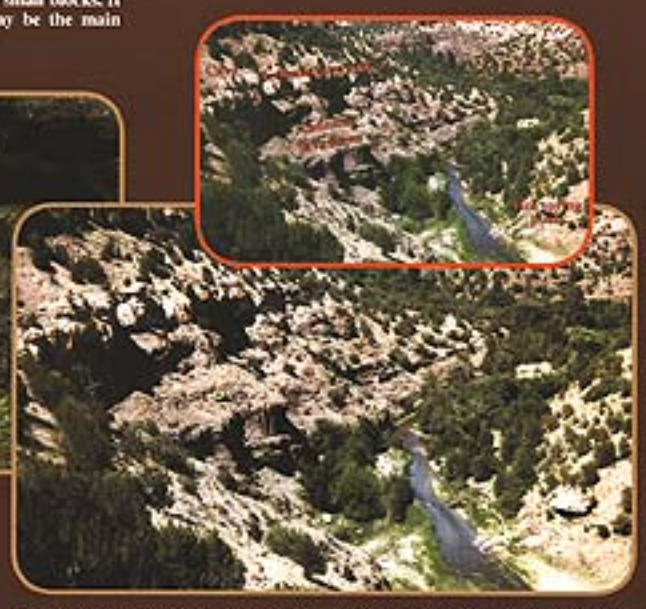


Figure 3. Example of a cave formed along the contact between dark-brown andesitic lava flows beneath, and softer, light-colored sedimentary rocks above. Cave is several hundred feet above the Middle Fork of the Gila River, opposite the lower Middle Fork hot spring, about ½ mile up river from the trailhead north of the Visitor Center. Hot spring pools are visible in the photo, on the east side of the river.

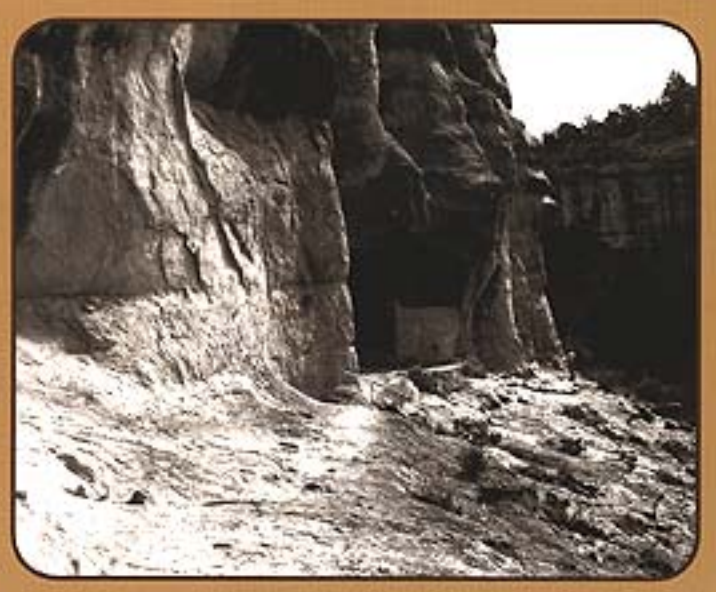
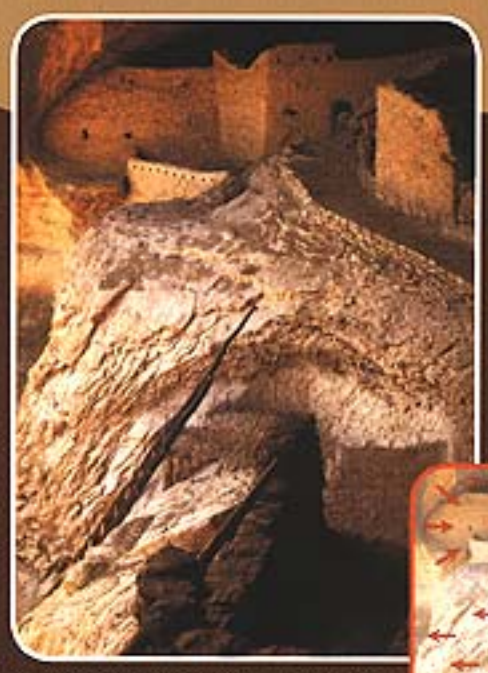


Figure 4. View north along Cliff Dwellings Trail toward Cave number 3 shows prominent bedding plane fracture within Gila conglomerate at approximate level of caves. Fracture separates generally finer grained sandstone beds above the fracture from coarser boulder conglomerate beds, below. The contrasting hardness of the beds above and below the fracture may have helped to localize the excavation of the caves.

The Role of Exfoliation in the Development of the Caves

Exfoliation is the process by which thin (from less than a centimeter to several meters) concentric shells, scales, flakes, slabs, sheets, or plates of rock are successively broken loose from the outer surface of a larger rock mass; it is caused by physical, thermal, or chemical forces producing differential stresses within an expanding rock, such as rapid temperature changes in a desert region, or by the release of confining pressure (*pressure release jointing*) of a once deeply buried rock as it is brought nearer to the surface by erosion. It often results in a rounded rock mass, a dome-shaped hill, or enlargement of a cave.



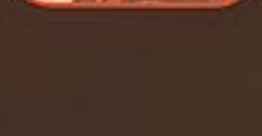
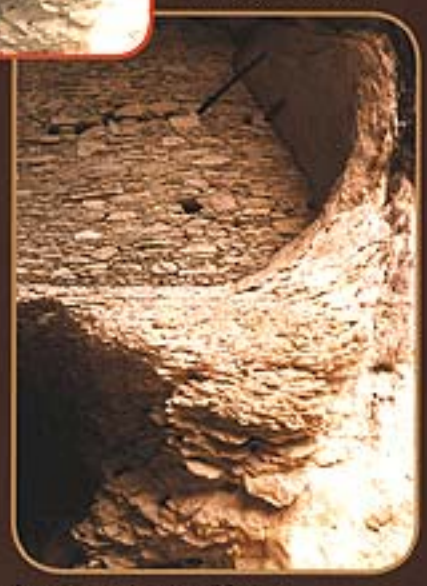


Figure 5. Cave number 4 showing exfoliation plates on outer face parallel to ladder and canyon wall, in floor of cave, and concentric with curving wall at left side of cave. Direction of pressure release for different free surfaces is shown by red arrows on inset. (Photo used by permission of photographer Laurence Parent)

Figure 6. Exfoliation slabs in the roof of Cave number 4. Cave enlargement by pressure release exfoliation in the roof is probably one of the most effective mechanisms of enlargement because it has gravity as an aid. Recent discovery of a fallen roof slab with soot on the underside indicates that it fell to the floor during or since the time the cave was occupied.

Figure 7. North end of Cave number 5 showing exfoliation shells conforming to curvature of cave opening. Red arrows show direction of pressure release.



General Location Map
Gila Cliff Dwellings
National Monument

U.S. Department of the Interior
U.S. Geological Survey
in cooperation with the National Park Service

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Reference Cited
Bradley, William C., 1963, Large-scale exfoliation in massive sandstones of the Colorado Plateau: Geological Society of America Bulletin, v. 74, p. 519-528.