

Figure 16. Map. Topographic map showing locations of unstable slopes in Mesa Verde National Park.

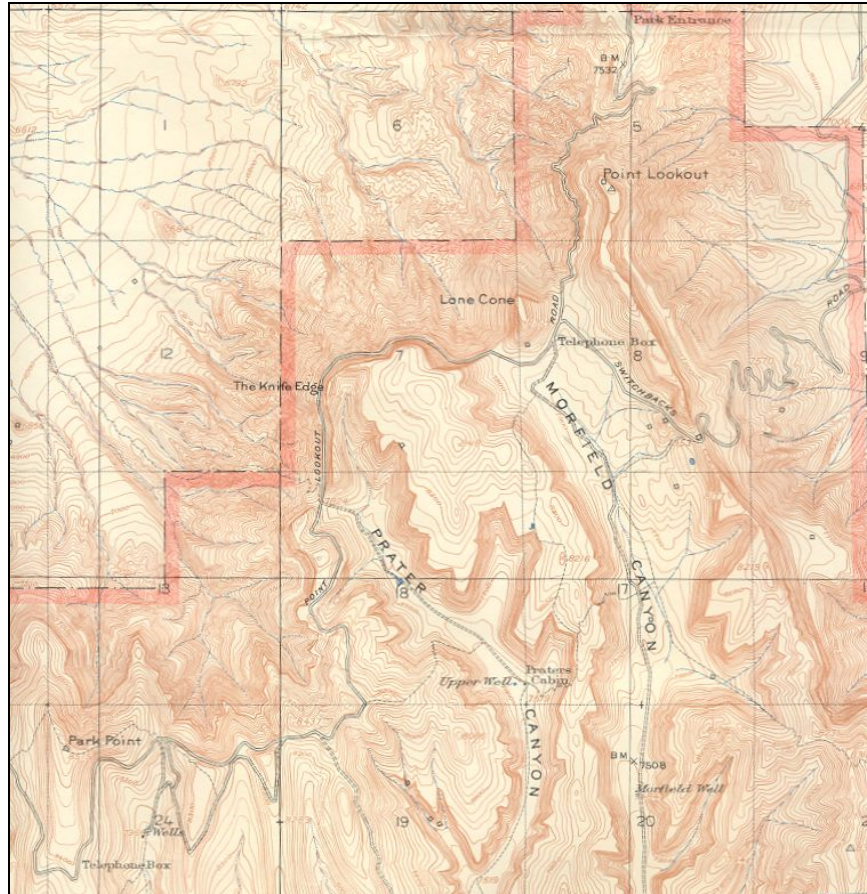


Figure 17. Map. Topographic map circa 1926 showing original alignment of Main Access Road to the park.



Figure 18. Photo. Unstable slope near Mile Post 9.3 in Mesa Verde National Park, CO.

Figure 18 shows the MP 9.3 site, where a rock fall is occurring in the cut above the road and slumping is occurring below the road. This area was reconstructed in 1985 and there has been movement since; pavement cracking, a settling shoulder, and visible distress in the slope well below the road are evidence of this.

MP 8.9 was reconstructed in 1985; some indication of movement was apparently evident prior to November 1996, when a slope indicator (SI) was installed. The SI was read once on April 30, 1997, and indicated movement. A small failure occurred in the spring of 1997, followed by a major failure in the spring of 1998; this happened again in January 2000, where more of the toe slope moved and more of the road was lost. In 2000, the site was repaired with a flatter slope and additional drainage.

MP 8.6 was reconstructed in 1985 and slope failure began in the spring of 1989. SIs were installed in September 1994 and were monitored occasionally through April 1997; at the time they were monitored, the SIs showed movement. Initial mitigation was through small fill wall construction and finally by realignment away from the slope in 2001.

MP 8.3 was reconstructed in 1985 and slope failure began in the spring of 1989. SIs were installed in November 1996 and they show no movement through 1997. Movement has not been evident since 1989.

The Point Lookout Slide failed so significantly in 1959 that the Park was closed for an extended period, the slope was re-graded and the road was reconstructed. Movement continued through the 1980's and 1990's, a period where lightweight fill, tieback walls, ground anchors, re-grading, horizontal drains and drainage galleries were all installed to stabilize the slope and slow movement.

Suitability for InSAR

To determine the suitability of this site for InSAR monitoring, the five characteristics for site selection, listed previously in the section on the Summary of InSAR Suitability of Chapter 2, were reviewed.

- **Slope Alignment:** Of particular interest for the current evaluation were the slopes along the east side of Point Lookout, as indicated Figure 16. Since these slopes generally face an easterly direction, the slope alignment is good for satellite-based InSAR. Other slopes of interest are at MP 8.3, 8.6, 8.9 and 9.3, as also indicated in Figure 16. The slope at MP 8.9 is east facing. The other slopes have less favourable alignment: at MP 8.3 the slope faces northeast, at MP 8.6 the slope faces south, and at MP 9.3 the slope faces north.
- **Slope Grade:** Many of the slopes within Mesa Verde are extremely steep, with vertical sections. Thus, layover and shadow are significant problems in this area.
- **Image Coherence:** The relatively dry climate and sparse vegetation in the Mesa Verde area are both beneficial in yielding good temporal coherence for InSAR analysis. However, within the mountainous region the coherence is variable, with significant areas of moderate to poor coherence. There are numerous areas of layover and shadow that

preclude the use of InSAR for measuring ground movement. In particular, the slopes to the east of Point Lookout (encircled in blue in Figure 19) are within the layover regions and cannot be monitored by InSAR. As shown in Figure 19, the areas of more gentle relief generally have quite good coherence, especially outside the mountainous area. The poor coherence within the mountainous areas generally mirrors the topographic relief.

- Existing Site Data: Digital orthophotography with 1 m (3.3 ft) resolution is available for the Mesa Verde area. The photography was acquired in 1993 and orthorectified to a DEM from 1995.
- Data availability: There are ERS acquisitions available from 1992 to 2004. In particular, for the descending satellite pass along track 413 there are 16 ERS-1 acquisitions spanning 1992 to 1996, and 15 ERS-2 acquisitions from 1995 to 2002. Fine mode RADARSAT acquisitions were programmed specifically for this project, starting in August 2004 and continuing until August 2005.

Many of the slope alignments are good, and in particular, the slopes to the east of Point Lookout are aligned favorably for InSAR. However, layover and shadow are significant, and certainly restrict the areas in which InSAR may be applied. The suitability of the various sites in this region varies depending on the specific site topography.

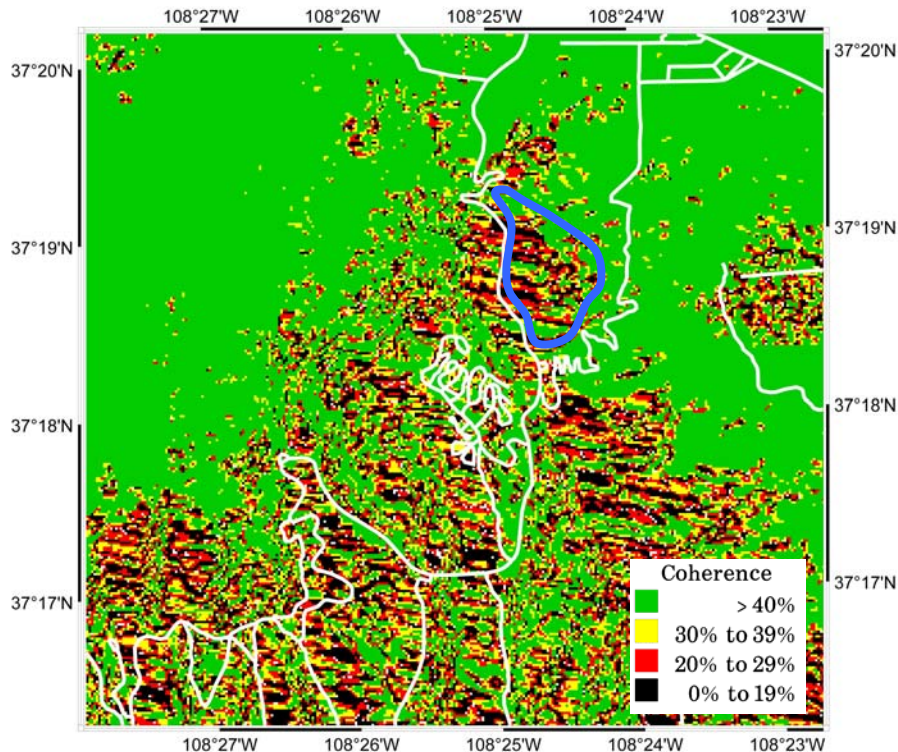


Figure 19. Graph. Coherence of Mesa Verde sites for May 28 – September 10, 1996.