Early on the morning of August 6th, 2007, a shallow earthquake measuring 3.9 Richter magnitude was recorded in Emery County, in central Utah. At approximately the same time, the underground works at the Crandall Canyon Coal Mine experienced a major "failure" (see http://epidote.wvgs.wvnet.edu/enviro/coalbumps.html) that left six miners unaccounted for. Below is an account from the Deseret Morning News from August 7, 2007 describing the events at the Mine.

Miners trapped — Crews working around clock to reach 6
By Sara Israelsen, Ben Winslow and Joe Bauman
Deseret Morning News

HUNTINGTON, Emery County — It could be days before rescuers are able to reach six miners trapped 1,500 feet underground in a collapsed mine shaft.

Getting to the men has been a difficult, round-the-clock operation, with a lot of setbacks.

Rescuers have encountered large amounts of debris, much more than anticipated. In the mine shafts, some debris continued to fall, risking the safety of workers trying to reach the trapped miners.

One attempt did not work as mine officials had hoped Monday.

"What I wanted to report was this worked, that we'd gotten to them," said Robert Murray, the president of Murray Energy, which owns the mine.

There has been no contact with the miners. The men are believed to have oxygen and water that could last them for days, but authorities admit they do not know if the men are alive or dead.

Rescuers have been working frantically to free the trapped miners. Crews are trying four different ways to get to the trapped miners, including drilling from inside and outside the mine and through a mountain. A specialized drill is expected to be brought in this morning to try another rescue attempt.

The men were among 10 people working in the coal mine Monday when it collapsed. They were about eight hours into a 12-hour shift when the area collapsed.

Four workers were able to evacuate safely, but the other six were trapped.

"They know where they're at in the mine," Emery County Sheriff Lamar Guyman said. "It's just a matter of getting to them."

Heavy equipment is being used in attempts to reach the men. The federal Mine Safety and Health Administration is coordinating the search efforts.

"The area where the miners are believed to have been working is about four miles from the mine entrance," MSHA spokesman Dirk Filipp said.

'It happens in mines'

Mining operations at Crandall Canyon have ceased, and employees are focused on rescue efforts. Miners showed up for their shifts Monday night dressed in their work clothes, sturdy shoes and carrying lunch pails and coolers.

Ryan Powell, a miner from East Carbon, sat in the back of a pickup with his co-workers ready to start a shift of rescuing.

"There's nothing you can do about it; he said of the collapse. "It happens in mines."

Buddy Mills has worked for 2 1/2 years at the Crandall Canyon Mine. He took the job because it pays well. He said they have been trained frequently on safety.

"The first thing to do in a collapse is to make sure you're OK; then try to find somebody else," he said. "Staying as a group is a big thing."

The area where the trapped miners are located is believed to have oxygen and water. They also had breathing apparatus, which had about an hour's worth of oxygen. Other apparatus are stashed throughout the mine, said Doug Johnson, the director of corporate services for Utah American Energy, which manages the Crandall Canyon Mine.

An earthquake?

The collapse inside the Crandall Canyon Mine was so powerful, authorities initially thought it was an earthquake.

An event measuring 3.9 on the Richter scale struck about 16 miles west of here at 2:48 a.m. Monday, Guyman said the University of Utah Seismograph Stations notified emergency dispatchers of the event, inquiring if it was an earthquake. A short time later, Emery County sheriff's dispatchers were notified of the mine collapse.

"We reported that the earthquake was in the Huntington Canyon area of the Wasatch Plateau, and it was apparent to us that the epicenter was in the vicinity of the Crandall Canyon Mine," said Walter Arabasz, the director of the University of Utah Seismograph Stations.

Murray dismissed reports that the mining could have caused a seismic event. He pointed to a map showing the epicenter about a mile from the trapped miners. Authorities said the event was at the same depth as where the men were working, in an old, sealed-off, mined-out portion of the mine.
Like many mines in the western United States, the Crandall Canyon Mine exploits Cretaceous coals. Not as famous or prolific as the coals of the Powder River Basin in Wyoming, coals of this age in Utah have, nevertheless, provided a considerable volume of resources for local and regional electrical power generation (see http://epidote.wvgs.wvnet.edu/enviro/coalsource.html) facilities. The Crandall Canyon Mine lies within Utah's Wasatch Plateau Coal Field. Sedimentary rocks in the Wasatch Plateau of Utah are generally gently dipping with few major faults. The Cretaceous coals of the region exhibit the same structural features. Unlike the coals of the Powder River Basin which are close to the surface in broad areas with little topographic relief, coals in the Wasatch Plateau occur in mountainous terrain with 1,000 to 2,000 feet of relief. The Crandall Mountain Mine is an underground working referred to as a drift mine. This type of mine is undertaken when a vein of minerals or seam of coal crops out on a mountainside. The mine's portal or entrance is excavated into the outcrop and then the mine shaft follows or drifts along the vein or seam as it continues back into the interior of the mountain. The coal being mined at Crandall Canyon is (or was) found in the Late Cretaceous Blackhawk Formation which consists of interbedded sandstone, siltstone, shale, and coal. Rocks and coal in the vicinity of the Mine dip at an angle of less than 10° to the west or northwest. The Mine occurs in an uplifted structural feature called a horst bounded ~2 miles to the east by the faulted margin of the Pleasant Valley Graben and ~5 miles to the west by the faulted margin of the Joe's Valley Graben. These faults are not considered to be active. On the next page is a map of Utah coal fields (left) and a generalized geologic map of Utah (right).
Place annotation on the topographic map as requested and answer the questions.

1. Draw a north arrow on the map shown on the next page.

2. Pick a "square" section in the northeast or southeast corner of the map area and determine the map scale.

3. Why do you think so many of the sections in this map area are not square?

4. What is the approximate area covered by the Crandall Canyon Mine (in square miles)?

5. The coal seam being mined at the Crandall Canyon Mine was approximately 10 feet thick. Calculate the volume of coal (in cubic feet and acre feet) present in the mine area before any mining took place.

6. Examine the coal rank map (http://epidote.wvgs.wvnet.edu/enviro/coalrank.html) for the United States. What type of coal is being mined at the Crandall Canyon Mine?
7. Find the Specific Gravity (a measure of relative density) for Crandall Canyon coal (see [http://www.uky.edu/KGS/coal/estimatingTons.htm](http://www.uky.edu/KGS/coal/estimatingTons.htm)) and determine the total number of short tons (2000 pounds) of coal present at the mine site prior to mining.

8. Using a reasonable heating factor of 12,000 BTU/pound, determine how many BTU's of energy are represented by the coal at the Crandall Canyon Mine site.

9. What states besides Utah use Wasatch Plateau coal for electricity generation?

10. Wyoming coal is shipped all across the United States to electrical power plants. Why is Utah coal not as widely distributed?

11. The Crandall Canyon Mine lies on the eastern margin of the Basin and Range Physiographic Province (see [http://en.wikipedia.org/wiki/Basin_and_Range](http://en.wikipedia.org/wiki/Basin_and_Range)). Specifically, the Mine is on a
*horst* and is surrounded by *graben* to the east and west. What are horst and graben? Are they associated with faults? What kind? Draw a simple cross-section through a series of horst and graben complete with fault-motion arrows.

12. Examine the seismic hazards map for the United States [http://epidote.wygs.wvnet.edu/enviro/seismic.html](http://epidote.wygs.wvnet.edu/enviro/seismic.html). Would you consider the Crandall Canyon Mine to be in a "high," "moderate," or "low" risk area for earthquakes?

13. Despite claims to the contrary, activities at Crandall Canyon were in the final phases of *retreat mining* prior to closure of the Mine. This type of underground mining is designed to get the last remaining coal out of the mine workings. Describe how retreat mining works. What holds up the roof of a coal mine when the last remaining coal pillars are removed?

14. Some people have suggested that the coal at Crandall Canyon could have been mined by the open-pit method. Are they correct? Why or why not?

15. What is your theory on the collapse at the Crandall Canyon Mine? What additional evidence would you need to prove your theory?