On the Cover:
Aerial Photograph of the Morgan Coal Mine Fire
Detail of map showing location of the Morgan Coal Mine Fire

Published by:
State of Colorado
  Bill Owens, Governor
Department of Natural Resources
  Russell George, Executive Director
Division of Minerals of Geology
  Ron Cattany, Director
1313 Sherman Street, Room 215
Denver, Colorado 80209
303.866.3567
www.mining.state.co.us
REPORT ON THE STATUS OF FIRES AT ABANDONED UNDERGROUND COAL MINES IN COLORADO

JANUARY 10, 2005

COLORADO DIVISION OF MINERALS AND GEOLOGY
STEVE RENNER, PROJECT MANAGER
This report is dedicated to my friend and colleague David Bucknam. Dave was an unceasing source of encouragement, motivation and friendship to myself and my comrades in the Colorado Inactive Mines Program.

Dave played a significant role in my career within the Inactive Mines Program by encouraging me to pursue my goals and interests and by providing moral support when the path became difficult. Dave offered counsel, advice, criticism, and exercised immeasurable patience.

Dave was my friend and mentor who has forever had an impact on my life, and to whom I am eternally grateful.

Steve Renner
December 17, 2004
Grand Junction, Colorado
INTRODUCTION ................................................................. 1
Terms .................................................................................. 1
Site Observations ............................................................. 2
Dormant Fires .................................................................... 2
Other Agency Coordination ........................................... 3

ACTIVE UNDERGROUND FIRE EVALUATIONS BY COUNTY .... 4
Boulder County ................................................................. 4
  Lewis Numbers 1 and 2 Coal Mine Fire .......................... 4
  Marshall Number 1 and 2 Coal Mine Fire .................... 6
Delta County ................................................................. 8
  States Coal Mine Fire ..................................................... 8
  Minnesota Creek Coal Mine Fire ................................. 10
Fremont County ............................................................ 12
  Double Dick Vicinity Coal Mine Fire ............................ 12
Garfield County ........................................................... 14
  IHI Number 3 (D&H) Coal Mine Fire ......................... 14
  Haas (IHI Number 2) Coal Mine Fire .......................... 16
  New Castle Number 3 Coal Mine Fire ......................... 17
  Morgan Coal Mine Fire ................................................ 19
  Elk Creek Coal Mine Fire ............................................. 20
  Harvey Gap Coal Mine Fire .......................................... 22
  Vulcan Coal Mine Fire .................................................. 24
  New Castle Number 1 Coal Mine Fire .......................... 25
  Coryell Coal Mine Fire ................................................ 26
  South Cañon Number 1 Coal Mine Fire ....................... 28
  Gem (South Canyon Number 2) Coal Mine Fire ........... 32
  Pocahontas Number 1 and 2 Coal Mine Fire ............... 34
  Sunshine Coal Mine Fire .............................................. 36
Gunnison County ........................................................... 38
  Oliver Coal Mine Fire .................................................. 38
Jackson County ........................................................... 40
  Riach Coal Mine Fire .................................................. 40
Las Animas County ......................................................... 42
  Morley Waste Dump Fire ............................................ 42
Mesa County ................................................................. 43
  Go Boy Coal Mine Fire ............................................... 43
  Garfield Coal Mine Fire .............................................. 44
  Farmers Mutual Coal Mine Fire ................................. 45
Moffat County ............................................................... 46
  Streeter / Collom Coal Mine Fire ............................... 46
  Wise Hill Number 3 / Hart Coal Mine Fire ............... 48
Montezuma County ......................................................... 52
  McElmo Coal Mine Fire ............................................. 52
Ouray County ................................................................. 54
  Slagle/Bright Diamond Coal Mine Fire ....................... 54
## LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Known Active Coal Mine Fires in Colorado</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Active Coal Mine Fires by County</td>
<td>63</td>
</tr>
<tr>
<td>3</td>
<td>Dormant Coal Mine Fires by County</td>
<td>65</td>
</tr>
<tr>
<td>4</td>
<td>Status of Sites Where Underground Fire Control Work Has Been Accomplished</td>
<td>67</td>
</tr>
<tr>
<td>5</td>
<td>Vent Temperature Measurements at Harvey Gap Fire Before, During and After Injection</td>
<td>68</td>
</tr>
<tr>
<td>6</td>
<td>Coal Outcrop Fires by County</td>
<td>70</td>
</tr>
</tbody>
</table>

## LIST OF FIGURES AND PHOTOGRAPHS

<table>
<thead>
<tr>
<th>Photograph</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minnesota Creek Mine Fire</td>
<td>Map Location Of States Mine Fire, And The Dormant Independent</td>
<td>5</td>
</tr>
<tr>
<td>Marshall Number 1 and 2 Mine Fire</td>
<td>Map Locations Marshall Numbers 1 &amp; 2, And Lewis Numbers 1 &amp; 2</td>
<td>6</td>
</tr>
<tr>
<td>States Coal Mine Fire</td>
<td>Map Location Of States Mine Fire, And The Dormant Independent No. 2 And Green Valley Mine Fires</td>
<td>8</td>
</tr>
<tr>
<td>Minnesota Creek Mine Fire</td>
<td>Map Location Of States Mine Fire, And The Dormant Independent</td>
<td>10</td>
</tr>
<tr>
<td>Double Dick Mine Fire Vicinity</td>
<td>Map Location Of Double Dick Mine Vicinity</td>
<td>12</td>
</tr>
<tr>
<td>IHI Number 3 and Haas Mine Fires</td>
<td>Map Location Of The D &amp; H, And Haas Active Mine Fires, And The Black Raven, W. H. Canyon And IHI Numbers 1 And 2 Dormant Coal Mine Fires</td>
<td>16</td>
</tr>
<tr>
<td>New Castle Number 3 Mine Fire</td>
<td>Photograph Coryell Mine Fire</td>
<td>18</td>
</tr>
<tr>
<td>Morgan Mine Fire</td>
<td>Photograph Morgan Mine Fire</td>
<td>19</td>
</tr>
<tr>
<td>Morgan Mine Fire</td>
<td>Map Locations of the Morgan and Elk Creek Mine Fires</td>
<td>19</td>
</tr>
<tr>
<td>Elk Creek Mine Fire</td>
<td>Photograph Elk Creek Mine Fire</td>
<td>21</td>
</tr>
<tr>
<td>Harvey Gap Mine Fire</td>
<td>Photograph Harvey Gap Mine Fire</td>
<td>22</td>
</tr>
<tr>
<td>Vulcan and New Castle Number 1 Mine Fires</td>
<td>Map Location Of The D &amp; H, And Haas Active Mine Fires, And The Black Raven, W. H. Canyon And IHI Numbers 1 And 2 Dormant Coal Mine Fires</td>
<td>24</td>
</tr>
<tr>
<td>New Castle Number 3 Mine Fire</td>
<td>Map Locations of the New Castle Number 3, Coryell, New Castle Number 1 and Vulcan Mine Fires</td>
<td>24</td>
</tr>
<tr>
<td>South Cañon Number 1 Mine Fire, West Fire Zone</td>
<td>Photograph South Cañon Number 1 Mine Fire</td>
<td>29</td>
</tr>
<tr>
<td>South Cañon Vicinity</td>
<td>Photograph South Cañon Number 1 Mine Fire, East Fire Zone</td>
<td>29</td>
</tr>
<tr>
<td>Gem Mine Fire</td>
<td>Photograph Gem Mine Fire</td>
<td>31</td>
</tr>
<tr>
<td>Gem Mine Fire Location</td>
<td>Photograph Gem Mine Fire</td>
<td>33</td>
</tr>
<tr>
<td>Pocahontas Mine Fire</td>
<td>Photograph Pocahontas Mine Fire, and the Dormant Oliver Number 2 Mine Fire</td>
<td>34</td>
</tr>
<tr>
<td>Locations of Pocahontas and Sunshine Mines</td>
<td>Photograph Pocahontas Mine Fire</td>
<td>34</td>
</tr>
<tr>
<td>Sunshine Mine Fire</td>
<td>Photograph Oliver Mine Fire</td>
<td>36</td>
</tr>
<tr>
<td>Locations of the Active Oliver Mine Fire, and the Dormant Oliver Number 2 Mine Fire</td>
<td>Photograph Vents at Riach Coal Fire</td>
<td>38</td>
</tr>
<tr>
<td>Locations of the Active Riach Mine Fire, and Nearby Dormant Mine Fires</td>
<td>Photograph Morley Waste Dump Fire</td>
<td>40</td>
</tr>
<tr>
<td>Location of Morley Waste Dump Fire</td>
<td>Map Location of Morley Waste Dump Fire</td>
<td>42</td>
</tr>
</tbody>
</table>
INTRODUCTION

Colorado is host to a rich mining history. Mining of both precious metals and coal helped establish the early economy of the State, dictated the location and importance of many of its towns and cities, and provided an important incentive for settlement of the West.

Coal mining was particularly important in the State’s formative years. To a greater or lesser extent, almost every citizen, and every industry, was dependent on coal extraction. As a result of this dependence, large and small coal mines were established wherever coal formations were discovered. Today, there are approximately 1,736 known abandoned, inactive coal mines located throughout Colorado.

Fires in abandoned coal mines are relatively rare occurrences. Of the approximately 1,736 known abandoned coal mines in Colorado, 32 are known to be involved at some level of combustion. This equates to under two percent of the known abandoned coal mines being currently involved in a combustion event. In addition to the burning abandoned coal mines, there are three known actively burning coal outcrop fires, and one fire in a coal refuse pile in Colorado. Approximately 50 additional abandoned coal mines are documented to have been on fire since their closure. These additional mine fires appear to be dormant at this time.

This report details the status of the known active and dormant underground coal mine fires in Colorado. The status of the coal outcrop fires and the refuse pile fire are also discussed, so that a complete picture of the status of all known coal fires in Colorado is provided.

Terms

In order to clarify the status of these fires, a number of terms are used throughout the report to describe each site.

The term active fire is used to describe a location where the combustion of coal causes an observable heating of the ground surface to a temperature exceeding ambient conditions at a similar, nearby site at the time of the field evaluation.

The term dormant fire describes a site where others had observed an active fire prior to the evaluation described in this report, but where indications of an active fire were not observed during the site evaluations conducted in 2002 and 2003. Coal combustion may be occurring underlying the ground surface, or conditions may not have been ripe for combustion at the time of the evaluation. Without obtaining site-specific subsurface data, it is difficult to confirm that any fire is extinguished. Others may use the term inactive fire to describe this same condition.

Research into production data yielded two terms that describe the coal extraction processes. Drift mine has been used to describe conventional room and pillar mining operations. The term as used in this report, describes a horizontal entry into a coal seam, with extraction resulting in open rooms devoid of coal, separated by pillars of coal left for roof and rib support.

The term slope mine has been used by others to describe any mine where the coal was accessed via an inclined, or sloping, entry, without necessarily implying a mining method. Frequently, slope mines used a room and pillar extraction technique. The term as applied here means that the coal was accessed by an inclined entry, and was extracted using room and pillar techniques.

Unfortunately, the term slope mine was also used to describe a mining technique employed in the Grand Hogback of Garfield County, and in other steeply dipping coal beds. The term stope mine is used in this report to describe a specific coal mining technique employed where the coal is steeply dipping. Using a stope mining technique, the steeply dipping coal was accessed either horizontally or on an incline. The entry, once it encountered the coal seam of interest, was driven horizontally into the coal, parallel with the strike of the seam. Coal extraction occurred overhead in long, stope-like rooms that followed the dip of the coal upwards. This resulted in finger-like areas of coal extraction extending upwards from the main entry. Blocks of supporting coal separated these long rooms.

The distinction between slope and stope mining is important because the different mining techniques appear to result in different fire characteristics. Stope mining results in a low-lying horizontal entry supporting a number of steeply pitched rooms from which coal was extracted. The rooms are bordered parallel with the entry by coal pillars. This combination of a low lying
entry with open, coal-bounded overhead rooms results in a chimney-like structure that is very efficient in moving air, and thus supports very active combustion.

A refuse pile fire is a fire occurring in the coal-bearing waste material extracted from an underground mine and deposited on the ground surface near the mine entry.

Outcrop fires are sites where in-place, un-mined coal is burning, generally as a result of natural processes, such as outcrop oxidation, ignition as a result of a wildfire or lightning strike. Outcrop fires resulting from human activities are not unheard of, but none are known to exist in Colorado at this time.

Site Observations
The observations detailed in this report are those obtained as a result of field evaluations of the surface characteristics of the subsurface fires. Inferences about the underlying fire were made as a result of these surficial observations. Because these inferences are not made on direct observation of subsurface conditions, actual conditions of the fire may vary from what is reported here. Drilling or other subsurface investigations are the only ways to obtain quantitative information about the nature of the fire itself. However, it is important to note that the surface characteristics of an underground fire such as subsidence features, fissures and fractures, elevated ground surface temperatures and unstable ground conditions are the factors that pose the greatest threat to human health and safety, and potentially a wildfire hazard.

In order to obtain a representative and reproducible data set, a field method was developed that contemplated collection of similar data at each site visited. Initially, each site was visually inspected from a distance in order to obtain a macro-scale characterization of the site. The perimeter of each site was walked to determine whether the area posed safety risks. Finally, the site was then walked to the extent that ground conditions permitted without taking undue risks. Individual fire related features were measured and logged using a hand held Global Positioning System instrument. Ground surface temperatures within or immediately adjacent to features were taken using a hand held infrared thermometer. Subsurface temperatures at refuse fires, and periodically at underground mine fires, were measured using a bi-metal ground temperature thermometer. This instrument was used to measure the ground temperature approximately eight inches below the surface, and within open vents. All temperatures presented in this investigation are reported in degrees Fahrenheit.

Observations of the fire related features were made to help quantify fire characteristics. Observations of thermal alteration of minerals, sulfur deposition and creosote deposition were made. Other observations such as alignment of features, positions of features relative to one another, growth of moss, ground stability, combustion smell and feature locations relative to vegetation were made.

Measurement of vent gas characteristics was attempted using a multi-gas meter suspended above venting features. Some data was produced using the meter, however a number of problems developed that ultimately suspended its use. A significant problem was that the temperature of the venting gas frequently surpassed the heat specifications of the meter, causing sensors to cease functioning. Another problem was that because the characteristics were measured at or near the point that the gas exited the ground, mixing with the atmosphere occurred, particularly on windy days. Therefore, the accuracy of the data was suspect to the point that, in some cases, it was deemed to be not useful. Vent gas characteristics data is provided in the report only from those sites where it appeared to be valid.

Qualitative assessments of the activity of the fires were made at most sites. These qualitative assessments included the relative activity of the fire, and its relative efficiency. Fires exhibiting a high degree of activity generally displayed active vents that vigorously produced combustion gasses. Some of the most vigorous vents dispel combustion gas with an audible exhausting sound. Less active fires predominately produced steam, rather than flue gas. Those fires termed efficient did not display a great quantity of precipitate at the vents, such as sulfur or creosote. The assumption was made that a hot, efficient fire would consume most of its fuel, and therefore would leave little residue at the ground surface. Conversely, it is assumed that an inefficient fire will display more significant deposition of combustion by-products.

Dormant Fires
In 1989, Rushworth et al, mapped approximately 54 mines as hosting “inactive” mine fires. These sites were observed from an aircraft during the winter of 2002 / 2003. The flights were made during the cold months because there is a higher probability of observing fire related features such as steam and smoke, and areas incapable of holding snow due to underlying heat. The vast majority of the sites were readily found. Three of the sites could not be located, even after extensive searching from the air. These were assumed to be no longer burning, and thus did not present any surface fire indicators. Each of the confirmed locations was photographed, and site observations documented. The observations recorded included the ability of the site to hold snow, vegetative changes observed and whether ground conditions
indicate signs of surficial instability. Five of the sites appeared to be somewhat anomalous, and therefore warranted a site investigation. Of these five sites, one was found to support an active fire.

**Other Agency Coordination**

Other governmental agencies have helped with this investigation by providing information and assistance. The agencies listed below have contributed to the Division’s efforts at controlling some fires.

The Office of Surface Mining has provided grant funds to complete the field investigations and this report. OSM has also provided grant funds necessary to conduct drilling operations, fire suppression projects and related activities.

The Bureau of Land Management has provided matching funds for a coal outcrop subsurface fire investigation and mitigation project in Mesa County. The BLM has also been a resource in providing location information for mine fires in western Mesa and Garfield counties, and regarding outcrop fires in Moffat and Mesa counties.

The National Park Service has identified a coal outcrop fire located in Mesa Verde National Park. As a result of that information, a site evaluation was completed. A fire mitigation plan has been developed, and abatement activities are scheduled to begin in spring, 2005.

The City of Glenwood Springs has provided survey data, aerial photographs and historical information pertinent to work being undertaken at the South Canyon mine fires. Provision of these materials has saved the Division considerable time and resources.