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Project 9256

Ground Survey of Las Animas County for Methane Anomalies

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Introduction

The Raton Basin is located in south central Colorado with an area of approximately 1,300 square miles. The Basin is underlain by two coal seams, the Raton and the Vermejo. These coal seams outcrop around and within the Basin. Raton and Vermejo coals have been mined for over one hundred years. Currently, the coals within the Basin are being drilled to produce methane. The coal bed methane development has been accompanied by concern from local government and the public about the impact to existing gas seeps. Production of methane may cause or enhance gas seepage. A project was undertaken by the Colorado Oil and Gas Conservation Commission (COGCC) to identify the existing conditions, and to the extent possible, identify and document conditions prior to coal bed methane development. In 2000, Apogee Scientific, Inc. (ASI) was contracted by COGCC to fulfill phase one of this project, a ground survey to locate methane seeps within the Raton Basin. Then in 2007 ASI was contracted by LT Environmental in a COGCC-funded effort to resurvey the Raton Basin. The phase two survey's goal was to determine any change in the status of gas seepage. This 2015 seep survey has been conducted to map out methane seeps in Las Animas County only.

This survey was conducted using a 4-wheel drive vehicle, similar to the one pictured in Figure 1, that was equipped with an infrared-based gas detector developed by ASI. This type of gas detector was designed to find leaks in natural gas pipelines, and is referred to as the Apogee Leak Detection System (LDS). The LDS is a three-channel instrument capable of measuring methane (CH_4), total hydrocarbons (HC), and carbon dioxide (CO_2) at sub part per million (PPM) concentrations at a speed of 10 samples per second. The vehicle was equipped with a high accuracy GPS and wind sensor that was used to mark the locations of seeps.

Figure 1. LDS-equipped ground survey vehicle.

The survey took place between May 15, 2015 and June 19, 2015. A total of 179 hours was spent surveying the Basin. During this time, 2933 miles were driven within the Basin where a total of 60 seeps were located.

Procedures

Equipment

The LDS consists of a high-speed gas analyzer that can detect methane, total hydrocarbons, and carbon dioxide in gas plumes at sub part per million concentrations. The LDS is coupled to the (GPS) receiver to determine vehicle location, and has a computer-based data acquisition system for data logging and display.

A comparison of the relative concentrations of the three gases helps determine the probable source of the emission being detected. For example, a plume with above background concentrations of methane and carbon dioxide will be likely coming from biological sources, such as cows, rather than from a methane seep. In addition, the presence of elevated total hydrocarbons, carbon dioxide, and methane is an indication that exhaust from a combustion source, such as an automobile, is being sampled.

The LDS was mounted in the rear of the survey vehicle. Ambient air was collected at the front of the vehicle at a height of approximately 18 inches above the ground, passed through a filter to remove particles and other debris from the air stream, and was carried to the LDS through 2 inch diameter pipe. The delay time between gas entering the entrance of the collection system and being detected by the LDS was on the order of 1 second.

The navigation system consisted of a Garmin GPS 18x GPS receiver. Output from the GPS receiver, in the form of NEMA 183B data sentences, was captured by the LDS data acquisition system which displayed the current vehicle location in real time on a map containing the path the vehicle had previously taken and all previously discovered seeps overlaid on a very detailed road map.

Wind speed and direction were measured using an Airmar PB200 ultrasonic wind sensor. The sensor was mounted at a height of 24 inches above the roof of the survey vehicle. The true wind direction was obtained by adding the apparent wind direction as measured by the wind sensor to the direction the vehicle was facing, which was obtained from the GPS. Wind speed and direction data was recorded manually with the vehicle stationary.

Data Collection

The survey vehicle was driven on public roads, lease roads, and jeep trails providing representative coverage of the Raton Basin, as shown in Figure 2 (on page 5). The areas of lighter coverage were due to mountains, private property that ASI did not have permission to enter, locked gates, or otherwise inaccessible roads.

The typical procedure followed while performing this survey was to drive the survey vehicle along the road/lease road/jeep trail being surveyed. The LDS display and audio output would be continually checked for indications of an elevated methane concentration. When a methane plume was detected, the vehicle was driven upwind into the plume, if possible, looking for the source of the methane plume. Plumes that could be identified as coming from gas production equipment or other expected methane sources were not recorded. The location of the leak was recorded in the LDS software and marked on the navigation program. The wind speed and direction were also recorded along with any comments and photographs of the leak site.

The survey vehicle was stopped at approximately 15-minute intervals to allow collection of wind speed and wind direction data. These measurements were made in flat, open areas where possible.

Results

As stated previously, between May 15, 2015 and June 19, 2015 a total of 2933 miles was surveyed within the Raton Basin, taking 179 hours. During this period a total of 60 separate seeps were found. A summary of these seeps is presented in Appendix A, and a map showing the locations of the seeps is shown in Figure 2. Also plotted in Figure 2 are the paths taken by the survey vehicle within the Raton Basin portion of Las Animas County and the seep locations found during the 2007 survey.

A companion compact disk (CD) to this report has been prepared which contains all of the data collected during this project. The contents of this CD are documented in Table I.

Table I. Contents of Supplemental Data CD

Filename	Description
Seeps.ZIP	A ZIP file containing an ESRI shapefile of the potential methane seep locations.
Seeps.xls	An EXCEL spreadsheet containing information about the potential methane seep.
WindData.ZIP	A ZIP file containing an ESRI shapefile of the wind speed and direction data.
WindData.xls	An EXCEL spreadsheet containing wind speed and direction data.
Track.ZIP	A ZIP file containing an ESRI shapefile of the path driven by the survey vehicle.
Pictures	A folder containing the pictures from Appendix I of this report.

Note: All shapefiles use the WGS84 geographic coordinate system with units of degrees [European Petroleum Survey Group (espg) code: 4326]

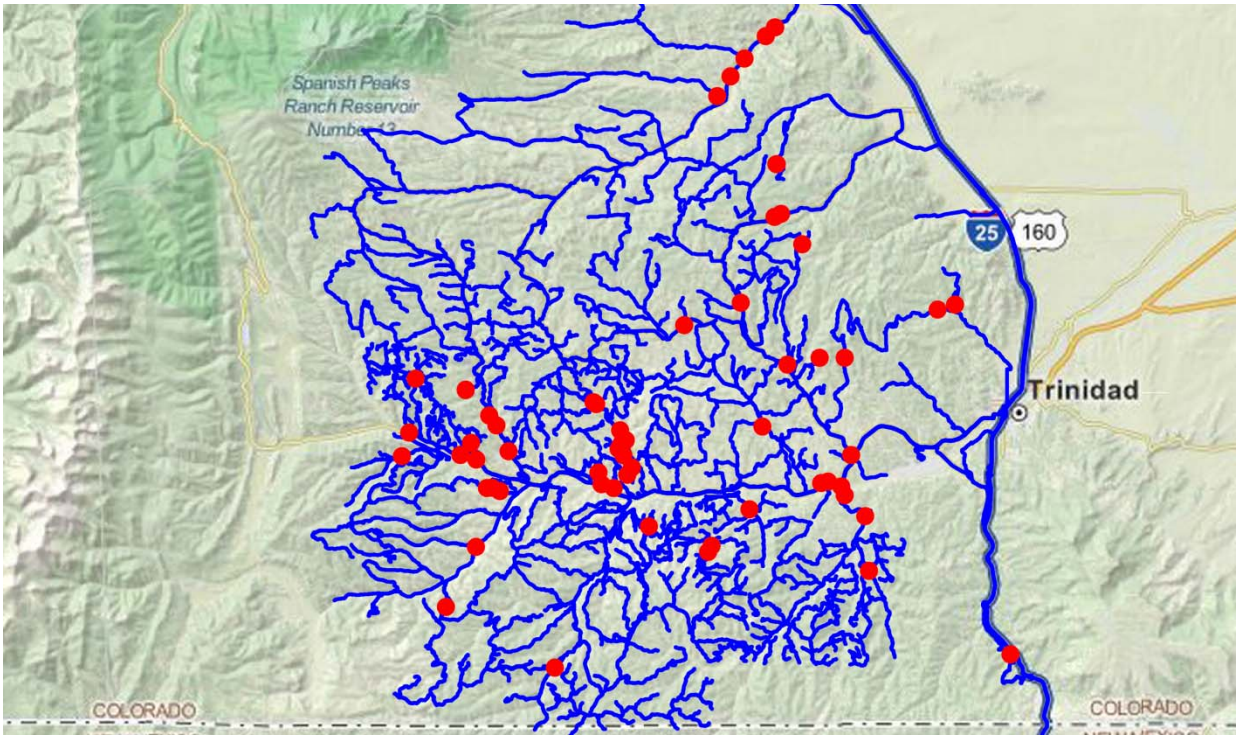

Figure 2. Map showing seeps detected during the 2015 survey (red boxes) and vehicle track (blue line).

Interpretation of Results

The presence of methane seeps in the Raton Basin is not surprising due to the large methane-containing coal beds present only a few hundred feet below the ground. Any activity that penetrates the overburden above the coal beds or removes water from the coal beds, either naturally occurring or due to the activities of man, has the potential to cause the release of methane.

The focus of this study was to discover the location of methane gas seeps. The survey vehicle was constrained to stay on the roads and jeep trails being surveyed, thus the precise locations of seeps that apparently came from inaccessible areas off the roads were not determined. With the recorded position where a plume intercepted the road as well as the recorded wind direction at that time, it should be relatively easy to find the leak source using hand-held leak survey equipment. The peak methane concentration measured at each seep was recorded and is presented in Appendix A. These peak concentrations are dependent on wind speed, measurement location, and other factors in addition to the methane emission rate, but can be used to infer relative seep rates.

The most obvious pattern to the methane seeps discovered in the Raton Basin is that they are continued to be clustered in the southern end of the Basin along the Purgatorie River valley through which Route 12 passes (Figure 2). This was also observed during the past two surveys.

Many of the seeps detected in 2000/2001 and 2007 were still existing and detectable in 2015. Current methane seeps were comparable or slightly lower in concentration to those observed in 2007.

Conclusions and Recommendations

There are many methane seeps in the Raton Basin, many of which are located in the southern portion of the Basin along the Purgatorie River valley. The cause of these seeps cannot be determined from this data set alone. However, when geological data, mine locations, gas well locations, and other data sets are combined with this data set, a much better understanding of the cause of methane seeps should be possible.

Appendix A

Summary of Methane Seeps

Potential Methane Seep

Date Found: 5/15/2015

Time Found: 1:02 PM

Wind Speed: 10.9 MPH

Wind Direction: 146°

Latitude: 37.158044

Longitude: -104.930955

Max Methane Conc.: 4.8 PPM

Seep ID: 1008

Description: An increase in ambient methane levels was detected south of CO Highway 12. Located south of the road is the Purgatoire River. Also, on the north shoulder of the road is a rock formation with visible coal seams. This seep is in the same location as a seep identified in the 2007 survey.

Looking at the Purgatoire River, just south of CO Highway 12.

Potential Methane Seep

Date Found: 5/15/2015

Time Found: 3:05 PM

Wind Speed: 4.4 MPH

Wind Direction: 304°

Latitude: 37.182278

Longitude: -104.890988

Max Methane Conc.: 0.7 PPM

Seep ID: 1015

Description: An increase in ambient methane levels was discovered northwest of Timber Ridge Rd. in the area of a dry creek bed. No moisture was present at this time, so methane from a swampy environment can be ruled out.

Looking northwest from Timber Ridge Rd. with the creek bed down below.

Potential Methane Seep

Date Found: 5/15/2015

Time Found: 3:29 PM

Wind Speed: 9.5 MPH

Wind Direction: 136°

Latitude: 37.162052

Longitude: -104.869280

Max Methane Conc.: 1.4 PPM

Seep ID: 1017

Description: An increase in ambient methane levels was detected near an embankment on the east side of County Rd. 31.9. A well pad is east of the seep approximately 0.15 miles. However, with trees in-between the pad and the seep location, as well as a narrow spike in methane, a seep is likely located along the road. This seep is also at the same location as a previous identified seep from the 2007 survey.

Looking south along Co Rd. 31.9 with the embankment on the left.

Potential Methane Seep

Date Found: 5/15/2015

Time Found: 3:55 PM

Wind Speed: 3.8 MPH

Wind Direction: 67°

Latitude: 37.129573

Longitude: -104.640074

Max Methane Conc.: 2.1 PPM

Seep ID: 1018

Description: An increase in ambient methane levels was detected coming from north of Highway 12. Located north of the road is a rock formation with exposed coal seams. Approximately 150ft. south of the highway is the Purgatoire River. This seep is at the same location as a previous identified seep from the 2007 survey.

Looking north at a rock formation/coal seams off of CO Highway 12.

Potential Methane Seep

Date Found: 5/16/2015

Time Found: 8:28 AM

Wind Speed: 4.6 MPH

Wind Direction: 197°

Latitude: 37.130513

Longitude: -104.635196

Max Methane Conc.: 2.6 PPM

Seep ID: 1019

Description: An increase in ambient methane levels was detected along CO Highway 12. This potential seep is located just ¼ mile east of Seep ID 1018. Located south of the anomaly is the Purgatoire River. On the north shoulder of the highway is an exposed coal seam. This seep is at the same location as a previous identified seep from the 2007 survey.

Looking south of CO Highway 12 at the Purgatoire River.

Potential Methane Seep

Date Found: 5/16/2015

Time Found: 9:35 AM

Wind Speed: 2.7 MPH

Wind Direction: 189°

Latitude: 37.188452

Longitude: -104.926222

Max Methane Conc.: 5.8 PPM

Seep ID: 1022

Description: An increase in ambient methane levels was detected in the proximity of a dry creek bed between a bend in Escondido Rd. This seep is at the same location as a previous identified seep from the 2007 survey.

A picture looking south of a dry creek bed which is in-between a bend on Escondido Rd.

Potential Methane Seep

Date Found: 5/16/2015

Time Found: 3:39 PM

Wind Speed: 1.8 MPH

Wind Direction: 219°

Latitude: 37.152205

Longitude: -104.887338

Max Methane Conc.: 3.1 PPM

Seep ID: 1026

Description: An increase in ambient methane levels was detected west of an unnamed leased road. A compressor station is about 500ft south, and a well pad is located 360ft to the north west. Due to winds coming from the south west, a seep at this location is credible.

Looking southwest of the unnamed leased road were abnormal methane levels were detected.

Potential Methane Seep

Date Found: 5/16/2015

Time Found: 4:06 PM

Wind Speed: 9.6 MPH

Wind Direction: 324°

Latitude: 37.142826

Longitude: -104.883464

Max Methane Conc.: 7.6 PPM

Seep ID: 1027

Description: An increase in ambient methane levels was detected near the side of a hill on the west side of an unnamed leased road. Exposed coal seams were visible on the hill.

Looking northwest on the unnamed leased road.

Potential Methane Seep

Date Found: 5/16/2015

Time Found: 4:20 PM

Wind Speed: 14.4 MPH

Wind Direction: 271°

Latitude: 37.145569

Longitude: -104.894763

Max Methane Conc.: 17.9 PPM

Seep ID: 1028

Description: Significant readings above ambient methane levels were detected on the west side of an unnamed leased road just north of CO Highway 12. On the west side of the road is a hill with exposed coal seams.

Looking west from the unnamed leased road in the vicinity where high methane levels were detected.

Potential Methane Seep

Date Found: 5/17/2015

Time Found: 5:41 PM

Wind Speed: 2.1 MPH

Wind Direction: 124°

Latitude: 37.346809

Longitude: -104.713484

Max Methane Conc.: 2.4 PPM

Seep ID: 1032

Description: An increase in ambient methane levels was observed coming from the southeast side of Trujillo Creek Rd. Thick brush and vegetation prevented any observation of distinguishing features. A dumpster is placed about 100ft to the west.

Looking southeast along Trujillo Creek Rd. where elevated methane readings were detected on the right side of the road.

Potential Methane Seep

Date Found: 5/17/2015

Time Found: 6:17 PM

Wind Speed: 2.6 MPH

Wind Direction: 43°

Latitude: 37.357957

Longitude: -104.703998

Max Methane Conc.: 13.7 PPM

Seep ID: 1035

Description: Significant readings above ambient methane levels were detected on the northeast side of County Rd. 43.7. This seep is at the same location as a previous identified seep from the 2007 survey.

Looking north on County Rd. 43.7 where methane was detected on the east side of the road.

Potential Methane Seep

Date Found: 5/17/2015

Time Found: 6:25 PM

Wind Speed: 6.1 MPH

Wind Direction: 14°

Latitude: 37.367877

Longitude: -104.694115

Max Methane Conc.: 2.7 PPM

Seep ID: 1036

Description: An increase in ambient methane levels was detected on the northeast side of County Rd. 43.7. No suspect features were observed

Looking south on County Rd. 43.7 where elevated levels of methane were detected on the left side of the road.

Potential Methane Seep

Date Found: 5/17/2015

Time Found: 6:41 PM

Wind Speed: 1.5 MPH

Wind Direction: 62°

Latitude: 37.380540

Longitude: -104.679230

Max Methane Conc.: 10.7 PPM

Seep ID: 1038

Description: An increase in ambient methane levels was detected on the northeast side of County Rd. 43.7.

Looking south on County Rd. 43.7. The elevated methane levels were detected on the left side of the road.

Potential Methane Seep

Date Found: 5/17/2015

Time Found: 6:49 PM

Wind Speed: 1.2 MPH

Wind Direction: 208°

Latitude: 37.385461

Longitude: -104.672713

Max Methane Conc.: 2.6 PPM

Seep ID: 1039

Description: An increase in ambient methane levels was detected on the southwest side of County Rd. 43.7. On the southwest side of the road is a rock formation with small fissures.

Looking at a rock formation on the southwest side of County Rd. 43.7 where elevated levels of methane were detected.

Potential Methane Seep

Date Found: 5/18/2015

Time Found: 9:18 AM

Wind Speed: 6.5 MPH

Wind Direction: 46°

Latitude: 37.135605

Longitude: -104.797240

Max Methane Conc.: 1.2 PPM

Seep ID: 1041

Description: An increase in ambient methane levels was detected on the northeast side of an unnamed leased road. On the northeast side of the road was a dry crevice with dead vegetation.

Over-looking the crevice located northeast of the unnamed leased road where the methane anomaly was recorded.

Potential Methane Seep

Date Found: 5/18/2015

Time Found: 3:19 PM

Wind Speed: 4.8 MPH

Wind Direction: 233°

Latitude: 37.167652

Longitude: -104.874477

Max Methane Conc.: 0.6 PPM

Seep ID: 1045

Description: A very small increase in ambient methane levels was detected in the vicinity of a dry creek bed southwest of County Rd. 31.9. This seep is at the same location as a previous identified seep from the 2007 survey.

A view of the dry creek bed located southwest of County Rd. 31.9 where the methane anomaly was detected.

Potential Methane Seep

Date Found: 5/18/2015

Time Found: 3:41 PM

Wind Speed: 6 MPH

Wind Direction: 215°

Latitude: 37.147612

Longitude: -104.860694

Max Methane Conc.: 2.9 PPM

Seep ID: 1047

Description: An increase in ambient methane levels was detected in the vicinity of a dry creek bed southwest of County Rd. 31.9. This is the same creek bed as Seep ID 1045, but about 1.5 miles south.

A view of the dry creek bed located southwest of County Rd. 31.9 where the methane anomaly was recorded.

Potential Methane Seep

Date Found: 5/19/2015

Time Found: 11:59 AM

Wind Speed: 4.2 MPH

Wind Direction: 307°

Latitude: 37.145412

Longitude: -104.61895

Max Methane Conc.: 3.6 PPM

Seep ID: 1050

Description: An increase in ambient methane levels was detected on the west side of County Rd. 57.7. An active stream is located on the west side of the road. Exposed coal beds are also scattered through the area.

A view of the west side of County Rd. 57.7 where the methane anomaly was recorded.

Potential Methane Seep

Date Found: 5/19/2015

Time Found: 12:41 PM

Wind Speed: 11.1 MPH

Wind Direction: 209°

Latitude: 37.200082

Longitude: -104.623425

Max Methane Conc.: 6.0 PPM

Seep ID: 1053

Description: An increase in ambient methane levels was detected in a creek bed west of an unnamed leased road. Normally the bed is dry, but at this time it was flowing. A small pond is located about 200ft beyond the creek bed.

Looking west of the unnamed leased road, the creek is in the depression in the center of the picture.

Potential Methane Seep

Date Found: 5/19/2015

Time Found: 2:08 PM

Wind Speed: 3.7 MPH

Wind Direction: 92°

Latitude: 37.227091

Longitude: -104.557813

Max Methane Conc.: 1.9 PPM

Seep ID: 1054

Description: An increase in ambient methane levels was detected on the east side of Baldy Canyon Rd. Located on the east side of the road is an active creek and rock formations.

A view looking east of Baldy Canyon Rd which shows the creek and rock formations.

Potential Methane Seep

Date Found: 5/19/2015

Time Found: 2:18 PM

Wind Speed: 3.2 MPH

Wind Direction: 158°

Latitude: 37.230005

Longitude: -104.545627

Max Methane Conc.: 7.9 PPM

Seep ID: 1055

Description: An increase in ambient methane levels was detected on the southeast side of an unnamed road. Located on the southeast side is a small ravine where water collects from run off.

Looking southeast, down a ravine where the methane anomaly was recorded.

Potential Methane Seep

Date Found: 5/19/2015

Time Found: 4:14 PM

Wind Speed: 5.2 MPH

Wind Direction: 51°

Latitude: 37.200189

Longitude: -104.641012

Max Methane Conc.: 2.0 PPM

Seep ID: 1057

Description: An increase in ambient methane levels was detected on the northeasat side of an unnamed leased road. On the northeast side of the road is a water run off ditch. At the time of the survey, the ditch was dry.

Looking east on the unnamed leased road. The methane anomaly was detected on the left side of this picture.

Potential Methane Seep

Date Found: 5/19/2015

Time Found: 4:54 PM

Wind Speed: 10 MPH

Wind Direction: 218°

Latitude: 37.231001

Longitude: -104.696860

Max Methane Conc.: 3.5 PPM

Seep ID: 1059

Description: An increase in ambient methane levels was detected on the southwest side of County Rd. 51.0. No suspect features are located in the immediate area. This seep is at the same location as a previous identified seep from the 2007 survey.

Looking southwest on County Rd. 51.0 where a methane anomaly was detected.

Potential Methane Seep

Date Found: 5/19/2015

Time Found: 5:18 PM

Wind Speed: 3.9 MPH

Wind Direction: 58°

Latitude: 37.279103

Longitude: -104.673010

Max Methane Conc.: 2.2 PPM

Seep ID: 1060

Description: An increase in ambient methane levels was detected on the northeast side of County Rd. 40.2. On the northeast side of the picture is a small hill and rock formations.

Looking northeast on County Rd. 40.2 at a hill where a methane anomaly was detected.

Potential Methane Seep

Date Found: 5/19/2015

Time Found: 5:25 PM

Wind Speed: 4.1 MPH

Wind Direction: 73°

Latitude: 37.280775

Longitude: -104.668322

Max Methane Conc.: 5.1 PPM

Seep ID: 1061

Description: An increase in ambient methane levels was detected on the northeast side of County Rd. 40.2. This potential seep was only ¼ mile east of Seep ID: 1060 on the same road. No suspect features are located in the immediate area.

Looking northeast on County Rd. 40.2 where a methane anomaly was detected.

Potential Methane Seep

Huerfano County

Date Found: 5/20/2015

Time Found: 2:21 PM

Wind Speed: 2 MPH

Wind Direction: 83°

Latitude: 37.519986

Longitude: -104.882058

Max Methane Conc.: 0.6 PPM

Seep ID: 1062

Description: An increase in ambient methane levels was detected on the east side of Co. Rd. 358. A hill is located on the southeast side of the road but covered in vegetation. No other suspect features are located in the immediate area. This seep is at the same location as a previous identified seep from the 2007 survey.

Looking southeast on Co. Rd. 358 where a methane anomaly was detected.

Potential Methane Seep

Date Found: 5/21/2015

Time Found: 9:59 AM

Wind Speed: 3.4 MPH

Wind Direction: 231°

Latitude: 37.127005

Longitude: -104.786465

Max Methane Conc.: 3.7 PPM

Seep ID: 1063

Description: An increase in ambient methane levels was detected on the west side of an unnamed leased road. On the west side of the road is a downward slope of a hill which bottoms out into a ravine.

Looking south on the unnamed leased road. The methane anomaly was detected on the right side of the picture.

Potential Methane Seep

Date Found: 5/21/2015

Time Found: 10:16 AM

Wind Speed: 3.8 MPH

Wind Direction: 116°

Latitude: 37.134315

Longitude: -104.776890

Max Methane Conc.: 7.9 PPM

Seep ID: 1066

Description: An increase in ambient methane levels was detected on the east side of an unnamed leased road. No suspect features are located in the immediate area.

Looking east on the unnamed leased road where a methane anomaly was detected.

Potential Methane Seep

Date Found: 5/21/2015

Time Found: 10:26 AM

Wind Speed: 12.5 MPH

Wind Direction: 131°

Latitude: 37.138471

Longitude: -104.773621

Max Methane Conc.: 0.6 PPM

Seep ID: 1067

Description: An increase in ambient methane levels was detected on the southeast side of an unnamed leased road. There is a buried methane pipeline on the northwest side of the road. Although, the pipeline is in close proximity of the methane anomaly, winds were strong out of the southeast and a seep cannot be ruled out.

Looking southeast on the unnamed leased road where a methane anomaly was detected.

Potential Methane Seep

Date Found: 5/21/2015

Time Found: 10:37 AM

Wind Speed: 2.3 MPH

Wind Direction: 105°

Latitude: 37.145235

Longitude: -104.779492

Max Methane Conc.: 2.1 PPM

Seep ID: 1068

Description: An increase in ambient methane levels was detected on the east side of an unnamed leased road. A small fissure with exposed coal seams is located south of the road.

Looking east on the unnamed leased road where a methane anomaly was detected.

Potential Methane Seep

Date Found: 5/21/2015

Time Found: 11:16:08 AM

Wind Speed: 3.8 MPH

Wind Direction: 167°

Latitude: 37.148898

Longitude: -104.783129

Max Methane Conc.: 1.0 PPM

Seep ID: 1076

Description: An increase in ambient methane levels was detected on the south side of an unnamed leased road. No suspect features are located in the immediate area.

Looking south on the unnamed leased road where a methane anomaly was detected.

Potential Methane Seep

Date Found: 5/21/2015

Time Found: 11:21 AM

Wind Speed: 6.3 MPH

Wind Direction: 162°

Latitude: 37.151149

Longitude: -104.781424

Max Methane Conc.: 0.7 PPM

Seep ID: 1077

Description: An increase in ambient methane levels was detected on the south side of an unnamed leased road. A natural gas well pad is located about 0.15 miles east of the methane anomaly.

Looking south on the unnamed leased road where a methane anomaly was detected.

Potential Methane Seep

Date Found: 5/21/2015

Time Found: 11:30 AM

Wind Speed: 6.3 MPH

Wind Direction: 100°

Latitude: 37.152485

Longitude: -104.779893

Max Methane Conc.: 2.3 PPM

Seep ID: 1078

Description: An increase in ambient methane levels was detected on the east side of an unnamed leased road. On the east side of the road is a dry gully for water runoff. A natural gas well pad is located about 0.10 miles southeast of the methane anomaly.

Looking east on the unnamed leased road where a methane anomaly was detected.

Potential Methane Seep

Date Found: 5/21/2015

Time Found: 11:34 AM

Wind Speed: 6.9 MPH

Wind Direction: 84°

Latitude: 37.153953

Longitude: -104.778991

Max Methane Conc.: 1.2 PPM

Seep ID: 1079

Description: An increase in ambient methane levels was detected on the east side of an unnamed leased road. On the east side of the road are some exposed coal seams.

Looking east on the unnamed leased road where a methane anomaly was detected. Notice the coal seams in the right corner.

Potential Methane Seep

Date Found: 5/21/2015

Time Found: 11:38 AM

Wind Speed: 10.1 MPH

Wind Direction: 170°

Latitude: 37.153875

Longitude: -104.778042

Max Methane Conc.: 5.3 PPM

Seep ID: 1081

Description: An increase in ambient methane levels was detected on the south side of an unnamed leased road. Located on the south side of the road is a dry creek bed and some rock formations. This methane anomaly is about 300ft east of Seep ID 1079 and both could be from the same source.

Looking south on the unnamed leased road where a methane anomaly was detected.

Potential Methane Seep

Date Found: 5/21/2015

Time Found: 12:31 PM

Wind Speed: 4.1 MPH

Wind Direction: 114°

Latitude: 37.159295

Longitude: -104.781898

Max Methane Conc.: 9.9 PPM

Seep ID: 1085

Description: An increase in ambient methane levels was detected on the east side of County Rd. 41.7. Located on the east side of the road is a creek bed and small rock formations. This seep is close to the same location as a previous identified seep from the 2007 survey.

Looking east on County Rd. 41.7 over a dry creek bed where a methane anomaly was detected.

Potential Methane Seep

Date Found: 5/21/2015

Time Found: 1:54 PM

Wind Speed: 3.3 MPH

Wind Direction: 152°

Latitude: 37.174055

Longitude: -104.798951

Max Methane Conc.: 4.3 PPM

Seep ID: 1088

Description: An increase in ambient methane levels was detected on the southeast side of Ponderosa Dr. A small water runoff is located on the south side of the road which was dry at the time of this survey. Coal seams are located on the north side of the road.

Looking south from Ponderosa Dr.

Potential Methane Seep

Date Found: 6/08/2015

Time Found: 5:58 PM

Wind Speed: 2.7 MPH

Wind Direction: 150°

Latitude: 37.161441

Longitude: -104.681703

Max Methane Conc.: 0.6 PPM

Seep ID: 1094

Description: An increase in ambient methane levels was detected coming from the southeast, parallel to Co. Rd. 53.5. A seep was discovered at this location in 2007, however now there is natural gas infrastructure in the area. Pipelines are located on both sides of the road and a well pad is located 400ft. to the east. Due to the lingering levels of methane and winds out of the southeast, the possibility of a seep cannot be ruled out.

Looking southeast on Co. Rd. 53.5.

Potential Methane Seep

Date Found: 6/09/2015

Time Found: 5:58 PM

Wind Speed: 3.1 MPH

Wind Direction: 275°

Latitude: 37.308878

Longitude: -104.671623

Max Methane Conc.: 2.2 PPM

Seep ID: 1096

Description: An increase in ambient methane levels was detected coming from the west of Ridgeline Spur Rd. The abnormal readings occur when the road makes a shallow 180 degree bend. In-between the bend is a heavily wooded ravine.

Looking northwest on Ridgeline Spur Rd. The ravine is beyond the trees.

Potential Methane Seep

Date Found: 6/10/2015

Time Found: 2:06 PM

Wind Speed: 2.4 MPH

Wind Direction: 103°

Latitude: 37.218490

Longitude: -104.736704

Max Methane Conc.: 11.6 PPM

Seep ID: 1106

Description: An increase in ambient methane levels was detected coming from the east side of Co. Rd. 30.1. Located on the east side of the road is a creek bed. On the west side of the road is a buried natural gas pipeline.

Looking east on Co Rd. 30.1. The creek bed is in the depression in the center of the picture.

Potential Methane Seep

Date Found: 6/10/2015

Time Found: 3:10 PM

Wind Speed: 4.6 MPH

Wind Direction: 305°

Latitude: 37.196238

Longitude: -104.663910

Max Methane Conc.: 5.6 PPM

Seep ID: 1107

Description: An increase in ambient methane levels was detected coming from the west side of an unnamed leased road. Located just west of the road is a creek bed where a seep was marked during the 2007 methane seep survey. Natural gas pipeline valves are located west of the road as well as this location is an active cow grazing field.

Looking west of the leased road, notice the creek in the background as well as the vertical pipe coming from the ground.

Potential Methane Seep

Date Found: 6/10/2015

Time Found: 4:01 PM

Wind Speed: 3.3 MPH

Wind Direction: 50°

Latitude: 37.263802

Longitude: -104.653422

Max Methane Conc.: 2.1 PPM

Seep ID: 1108

Description: An increase in ambient methane levels was detected coming from the northeast side of an unnamed road. Located on the northeast side of the road is a ravine that drops off into a dry creek bed. This seep is at the same location as a previous identified seep from the 2007 survey.

Looking northeast of the unnamed road where the ravine begins to drop off.

Potential Methane Seep

Date Found: 6/11/2015

Time Found: 10:42 AM

Wind Speed: 9.4 MPH

Wind Direction: 93°

Latitude: 37.144807

Longitude: -104.935952

Max Methane Conc.: 2.2 PPM

Seep ID: 1114

Description: An increase in ambient methane levels was detected coming from the east side of an unnamed leased road. This potential seep is located approximately 300ft northeast of a previous marked seep in the 2007 survey.

Looking east of the unnamed leased road where abnormal methane levels were detected.

Potential Methane Seep

Date Found: 6/11/2015

Time Found: 5:51 PM

Wind Speed: 1.1 MPH

Wind Direction: 269°

Latitude: 37.059991

Longitude: -104.904850

Max Methane Conc.: 0.8 PPM

Seep ID: 1122

Description: An increase in ambient methane levels was detected coming from the west side of an unnamed leased road. This potential seep is located approximately 500ft northeast of a previous marked seep in the 2007 survey. The west side of the road is a heavily wooded area.

Looking west of the unnamed leased road where the methane anomaly was detected.

Potential Methane Seep

Date Found: 6/11/2015

Time Found: 6:10 PM

Wind Speed: 3.0 MPH

Wind Direction: 233°

Latitude: 37.093898

Longitude: -104.883740

Max Methane Conc.: 0.2 PPM

Seep ID: 1123

Description: An increase in ambient methane levels was detected coming from the west which is parallel to an unnamed leased road. A pond was located on the south side of the road and on the north side of the road was a buried natural gas pipeline as well as a coal seam. This seep is about 500ft west of a previous identified seep from the 2007 survey.

Looking west on the unnamed leased road. The pond is just off to the left of the picture.

Potential Methane Seep

Date Found: 6/12/2015

Time Found: 10:08 AM

Wind Speed: 2.4 MPH

Wind Direction: 89°

Latitude: 37.126960

Longitude: -104.876023

Max Methane Conc.: 2.2 PPM

Seep ID: 1128

Description: An increase in ambient methane levels was detected coming from the east which is parallel to an unnamed leased road. Both a creek and a natural gas pipeline are located on the southeast side of the road. Located on the north side of the road is a mine vent.

Looking southeast at a creek and pipeline marker on the unnamed leased road.

Potential Methane Seep

Date Found: 6/12/2015

Time Found: 10:21 AM

Wind Speed: 2.0 MPH

Wind Direction: 93°

Latitude: 37.127213

Longitude: -104.872410

Max Methane Conc.: 3.0 PPM

Seep ID: 1130

Description: An increase in ambient methane levels was detected coming from the east which is parallel to an unnamed leased road. This seep is on the same road and creek as Seep ID 1128. The natural gas pipeline is now on the other side of the road.

Looking southeast at a creek on the unnamed leased road.

Potential Methane Seep

Date Found: 6/12/2015

Time Found: 10:27 AM

Wind Speed: 5.6 MPH

Wind Direction: 62°

Latitude: 37.125299

Longitude: -104.866815

Max Methane Conc.: 4.2 PPM

Seep ID: 1131

Description: An increase in ambient methane levels was detected coming from the northeast side of an unnamed leased road. This seep is on the same road and creek as Seep ID 1128 and Seep ID 1130. The pipeline and creek are now on the north side of the road.

Looking north at a creek on the unnamed leased road.

Potential Methane Seep

Date Found: 6/15/2015

Time Found: 4:48 PM

Wind Speed: 8.1 MPH

Wind Direction: 190°

Latitude: 37.025785

Longitude: -104.828107

Max Methane Conc.: 20.8 PPM

Seep ID: 1140

Description: An increase in ambient methane levels was detected coming from the south side of Hill Ranch Rd. Located south of the road is a small creek with wide banks. On the other side of the road is a buried transmission pipeline. However, the pipeline is buried 6-8ft and no dead grass is observed.

Looking south at a creek on Hill Ranch Rd where methane was detected.

Potential Methane Seep

Date Found: 6/15/2015

Time Found: 5:45 PM

Wind Speed: 8.2 MPH

Wind Direction: 76°

Latitude: 37.129003

Longitude: -104.795100

Max Methane Conc.: 2.3 PPM

Seep ID: 1142

Description: An increase in ambient methane levels was detected coming from the northeast side of CO Highway 12. Located north of the highway is a rock formation with exposed coal seams. The potential seep is located in the middle of a cluster of homes. This seep is about 300ft south of a previous identified seep from the 2007 survey.

Looking northeast at the rock formation on CO Highway 12. A home is just beyond the embankment.

Potential Methane Seep

Date Found: 6/16/2015

Time Found: 10:01 AM

Wind Speed: 2.1 MPH

Wind Direction: 6°

Latitude: 37.105241

Longitude: -104.761654

Max Methane Conc.: 0.4 PPM

Seep ID: 1145

Description: An increase in ambient methane levels was detected coming from the north side of an unnamed leased road. Located north of the road is a gully.

Looking north on the unnamed leased road where methane was discovered.

Potential Methane Seep

Date Found: 6/16/2015

Time Found: 10:55 AM

Wind Speed: 1.9 MPH

Wind Direction: 234°

Latitude: 37.090934

Longitude: -104.719981

Max Methane Conc.: 8.0 PPM

Seep ID: 1146

Description: An increase in ambient methane levels was detected coming from the southwest side of an unnamed leased road. There is no shoulder west of the road as the hill drops off into a valley. A well pad is located approximately 550ft to the southeast, but levels of methane were lower at the well than at the potential seep location.

Looking west on the unnamed leased road where methane was discovered.

Potential Methane Seep

Date Found: 6/16/2015

Time Found: 11:04 AM

Wind Speed: 5.3 MPH

Wind Direction: 164°

Latitude: 37.094529

Longitude: -104.717396

Max Methane Conc.: 7.6 PPM

Seep ID: 1147

Description: An increase in ambient methane levels was detected coming from the southeast side of an unnamed leased road. Located southeast of the road is a dry creek bed. Approximately 350ft to the east of the potential seep is a well pad; however levels of methane at the pad were lower than the detected anomaly.

Looking southeast on the unnamed leased road where methane was discovered. The dry creek bed is hidden by vegetation.

Potential Methane Seep

Date Found: 6/16/2015

Time Found: 6:18 PM

Wind Speed: 4.1 MPH

Wind Direction: 182°

Latitude: 37.033376

Longitude: -104.506374

Max Methane Conc.: 0.4 PPM

Seep ID: 1151

Description: An increase in ambient methane levels was detected coming from the south side of Fisher Peak Pkwy. To the south is a culvert with standing water at the bottom. Exposed coal seams are also visible. This potential seep is located ¼ miles from a previous seep found in the 2007 survey.

Looking south on Fisher Peak Pkwy. at the culvert with exposed coal seam.

Potential Methane Seep

Date Found: 6/17/2015

Time Found: 10:14 AM

Wind Speed: 2.8 MPH

Wind Direction: 57°

Latitude: 37.114861

Longitude: -104.690557

Max Methane Conc.: 18.7 PPM

Seep ID: 1152

Description: An increase in ambient methane levels was detected coming from the northeast which is parallel to an unnamed leased road. A pond is located approximately 360ft upwind and a horse corral is just south of the potential seep. Additionally, a waste water pipeline is located on the north side of the road and a natural gas pipeline is on the south side of the road.

Looking northeast on the unnamed leased road where methane was discovered.

Potential Methane Seep

Date Found: 6/17/2015

Time Found: 2:52 PM

Wind Speed: 3.5 MPH

Wind Direction: 345°

Latitude: 37.080284

Longitude: -104.606438

Max Methane Conc.: 0.5 PPM

Seep ID: 1153

Description: An increase in ambient methane levels was detected coming from the north which is parallel to an unnamed leased road. A dry creek bed runs parallel to the road.

Looking northeast on the unnamed leased road. The creek bed is hidden by vegetation.

Potential Methane Seep

Date Found: 6/17/2015

Time Found: 4:07 PM

Wind Speed: 2.3 MPH

Wind Direction: 57°

Latitude: 37.111030

Longitude: -104.609040

Max Methane Conc.: 22.7 PPM

Seep ID: 1154

Description: An increase in ambient methane levels was detected coming from the northeast of Co. Rd. 53.1. Located to the north east of the road is a creek and small rock formations. This seep is at the same location as a previous identified seep from the 2007 survey.

Looking northeast on Co. Rd. 53.1 where a methane anomaly was detected.

Potential Methane Seep

Date Found: 6/17/2015

Time Found: 4:17 PM

Wind Speed: 5.5 MPH

Wind Direction: 99°

Latitude: 37.122903

Longitude: -104.623465

Max Methane Conc.: 0.5 PPM

Seep ID: 1155

Description: An increase in ambient methane levels was detected coming from the east of Co. Rd. 18.3. Located to the east is a ravine with a dry creek bed at the bottom.

Looking east on Co. Rd. 18.3 where the methane anomaly was detected.

Potential Methane Seep

Date Found: 6/18/2015

Time Found: 1:34 PM

Wind Speed: 7.3 MPH

Wind Direction: 85°

Latitude: 37.127755

Longitude: -104.625900

Max Methane Conc.: 0.6 PPM

Seep ID: 1157

Description: An increase in ambient methane levels was detected coming from the east of Co. Rd. 18.3. The Purgatoire River runs parallel to this road to the north and northeast. No other suspect features are visible.

Looking east on Co. Rd. 18.3 where the methane anomaly was detected. The Purgatoire River is beyond the trees on the left hand side of the picture.

Potential Methane Seep

Date Found: 6/18/2015

Time Found: 2:13 PM

Wind Speed: 1.7 MPH

Wind Direction: 49°

Latitude: 37.175235

Longitude: -104.800628

Max Methane Conc.: 7.6 PPM

Seep ID: 1158

Description: An increase in ambient methane levels was detected coming from the northeast of Co. Rd. 41.7. A dry creek bed is located on the northeast side of the road. This possible seep is located approximately 1000ft from a previous seep located in the 2007 seep survey.

Looking northeast on Co. Rd. 41.7 where the methane anomaly was detected.