Field Report for Airborne Data Collected In Support of US EPA Region VI ExxonMobil Baytown Fire 31 July 2019

Background

On 31 July 2019 an explosion and subsequent fire was reported at the ExxonMobil Baytown refinery located west of the city of Baytown, TX. Local reports indicate that shortly after 1100 local an explosion and resulting fire was observed within the olefin unit at the ExxonMobil Refinery and Chemical facility. Up to 37 minor injuries were reported as a result of the accident and local media provided images and video of the unit on fire and a towing column of black smoke being emitted from the site. At 1425 local, the facility reported the unit had been isolated (blocked in) and plant personnel were spraying water on the impacted unit. The geographical coordinates of the facility are 29.7584N, 95.0067W (figure 1).

Figure 1. ExxonMobil Baytown Fire (Source: express.co.uk)

The US EPA Region VI requested that the ASPECT system be deployed, and the aircraft reported airborne status at 1447. This report summarizes findings observed during the mission.

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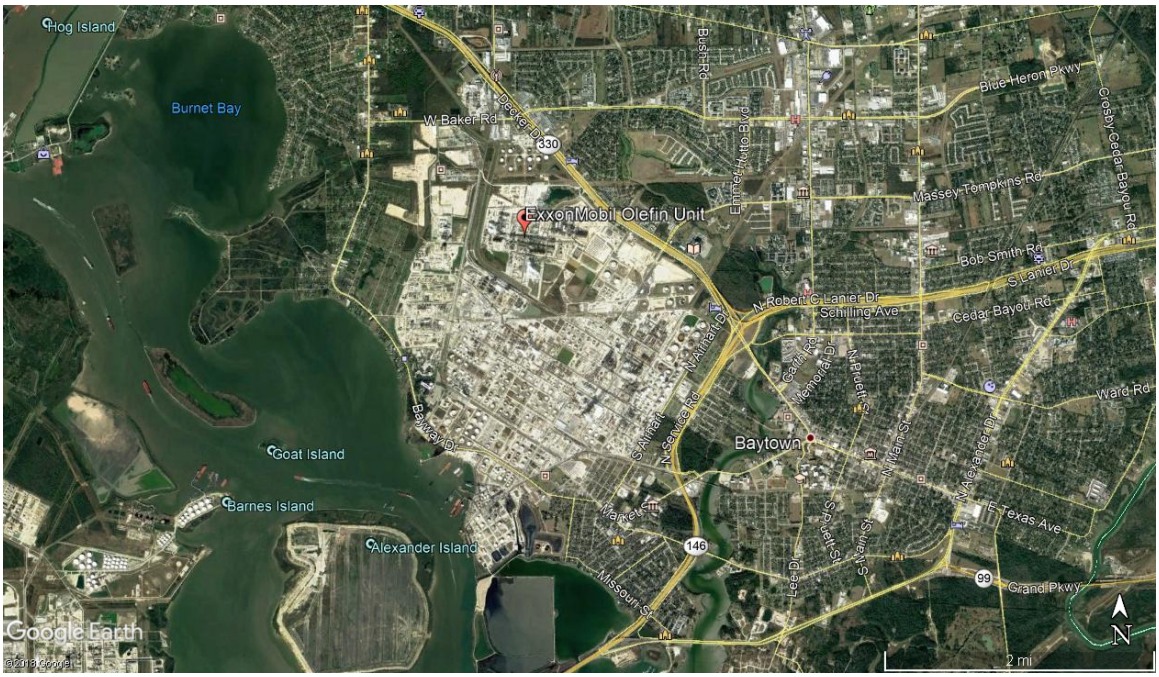

Figure 1: ExxonMobil Facility, Baytown, TX

ASPECT response to this Mission/Incident was in support of:
US EPA Region 6. OSC: Greg Fife

ASPECT System

The US EPA ASPECT system collects airborne infrared (IR) images and chemical screening data from a safe distance over the site (about 3,000 ft AGL). The system consists of an airborne high speed Fourier transform infrared spectrometer (FTIR) coupled with a wide-area IR line scanner (IRLS). The ASPECT IR systems have the ability to detect compounds in both the 8 to 12 micron (800 to 1200 cm-1) and 3 to 5 micron (2000 to 3200 cm-1) regions. The 8 to 12 micron region is typically known as the atmospheric window region since the band is reasonably void of water and carbon dioxide influence. Spectrally, this region is used to detect carbon - non-carbon bonded compounds. The 3 to 5 micron region is also free of water and carbon dioxide but typically does not have sufficient energy for use. This band does show use in high-energy environments such as fires. The carbon - hydrogen stretch is very common in this region.

A digital Nikon DX2 camera (12.4 mega pixel CMOS 3:5 aspect ratio, 28 mm wide-angle lens) collects visible aerial imagery as part of the core data product package. The camera timing system is connected to the primary IR sensors and provides concurrent image collection when other sensors are triggered. All imagery is geo-rectified using both aircraft attitude correction (pitch, yaw, and roll) and GPS positional information. Imagery can be processed while in flight or approximately 600 frames per hour can be processed once the data are downloaded from the aircraft.

An Imperx mapping camera (29 mega pixels; mapping focal plane array) provides a similar aspect ratio and aerial coverage. Like the Nikon DX2, it is connected to the primary IR sensors and provides concurrent image collection when other sensors are triggered. These images are often digitally processed in lower resolution, so they can be transmitted via satellite communication. The high-resolution images (>20 MB each) are pulled from the ASPECT after the sortie and are available at a later time.

All aerial photographic images collected by the ASPECT system are ortho-rectified and geospatially validated by the reach back team. In general, this consists of conducting geo-registration using a Digital Elevation Model (DEM) which promotes superior pixel computation and lessens topographic distortion. The image is then check by a team member (using a Google Earth base map) for proper location and rotation

Data is processed using automated algorithms onboard the aircraft with preliminary results being sent using a satellite system to the ASPECT reach back team for QA/QC analysis. Upon landing preliminary data results are examined and validated by the reach back team.

Weather Conditions and Crew Report

Weather for the mission is given in table 1. The crew reported that winds at altitude (3000 ft) were from the southwest at 11 kts. Light smoke was observed drifting to the north and no fire was observed. Light turbulence was reported in the later part of the mission.

Table 1. ExxonMobil Baytown Fire Weather

Parameter	Surface (1500)	Surface (1600)	Surface (1715)
Wind direction	035 degrees	150 degrees	180 degrees
Wind speed	1.5 m/s (4 mph)	1.7 m/s (6 mph)	1 m/s (2 mph)
Temperature	32,5ºC	33.3ºC	32.2ºC
Humidity	63%	61%	60%
Dew Point	25.5ºC	25.5ºC	24.4ºC
Pressure	1001 mb	1000 mb	1000 mb
Ceiling	3000 ft, broken	3000 ft, few	3000 ft, few

Flight Status

The order to launch the aircraft was given at 1210 local on 31 July2019 and the aircraft was airborne at 1447. The estimated flight time to the target was estimated as 75 minutes. The aircraft made the first data collection pass at 1613 local and conducted 11 passes before departing for fuel at 1527 for low fuel. Flight information is summarized in Appendix A and Figure 2.

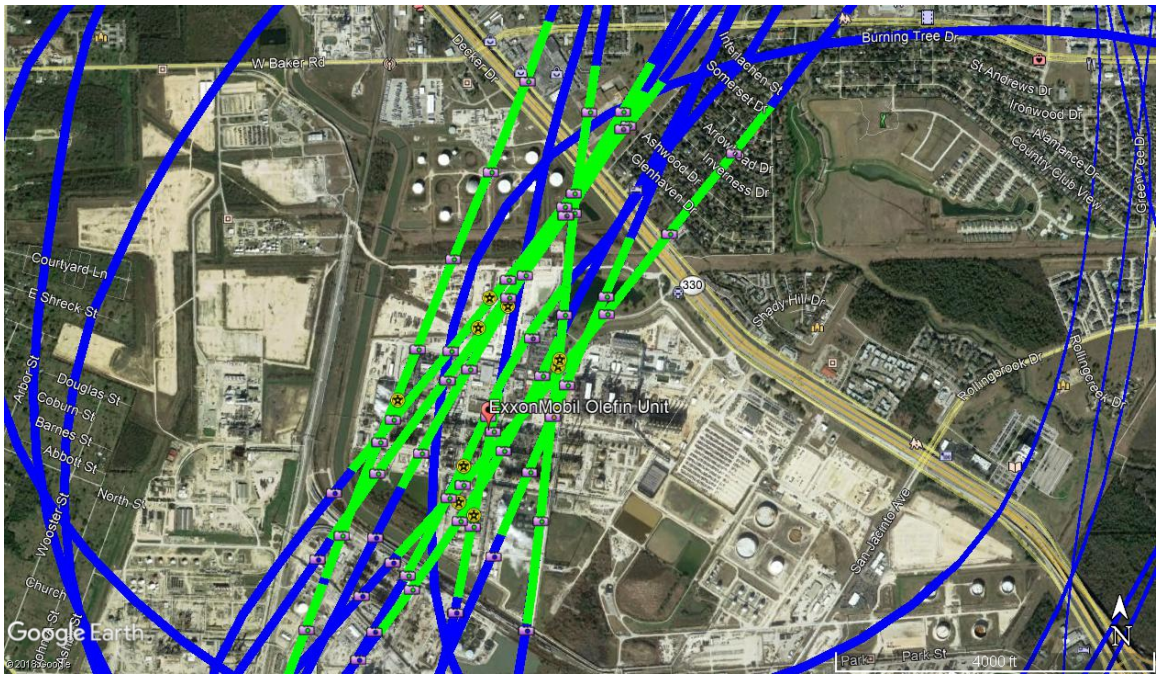

Figure 2: Data collection passes, ExxonMobil Baytown Fire. The blue lines represent the ASPECT flight path, green lines represent when the FTIR was actively collecting data, the yellow icons with star is the centroid of the line scanner image, and the camera icons represent when a photo was taken.

Data Results

General Data Quality Objective

The following general data quality objectives are employed in conducting emergency response data collection with ASPECT:

1. To support overall situational analysis of the incident including aerial photography and IR imagery
2. To screen the incident for the presence of selected chemicals
3. To estimate the location and concentration of plumes being generated by the incident.

Line Scanner Data Results

A total of 1 test and 11 data passes were made in the proximity of the fire and an infrared line scanner image was generated for each pass. Figure 3 shows a typical 3-band infrared image obtained from data collected for Run 2. This image was generated by flying directly over the facility. The two white spots on the lower portion of the image are hot signatures from operating flares. Area west of the large building in the image is the hot signature of the fire. No observable plume is present confirming that the pilot reports of a light plume is accurate.

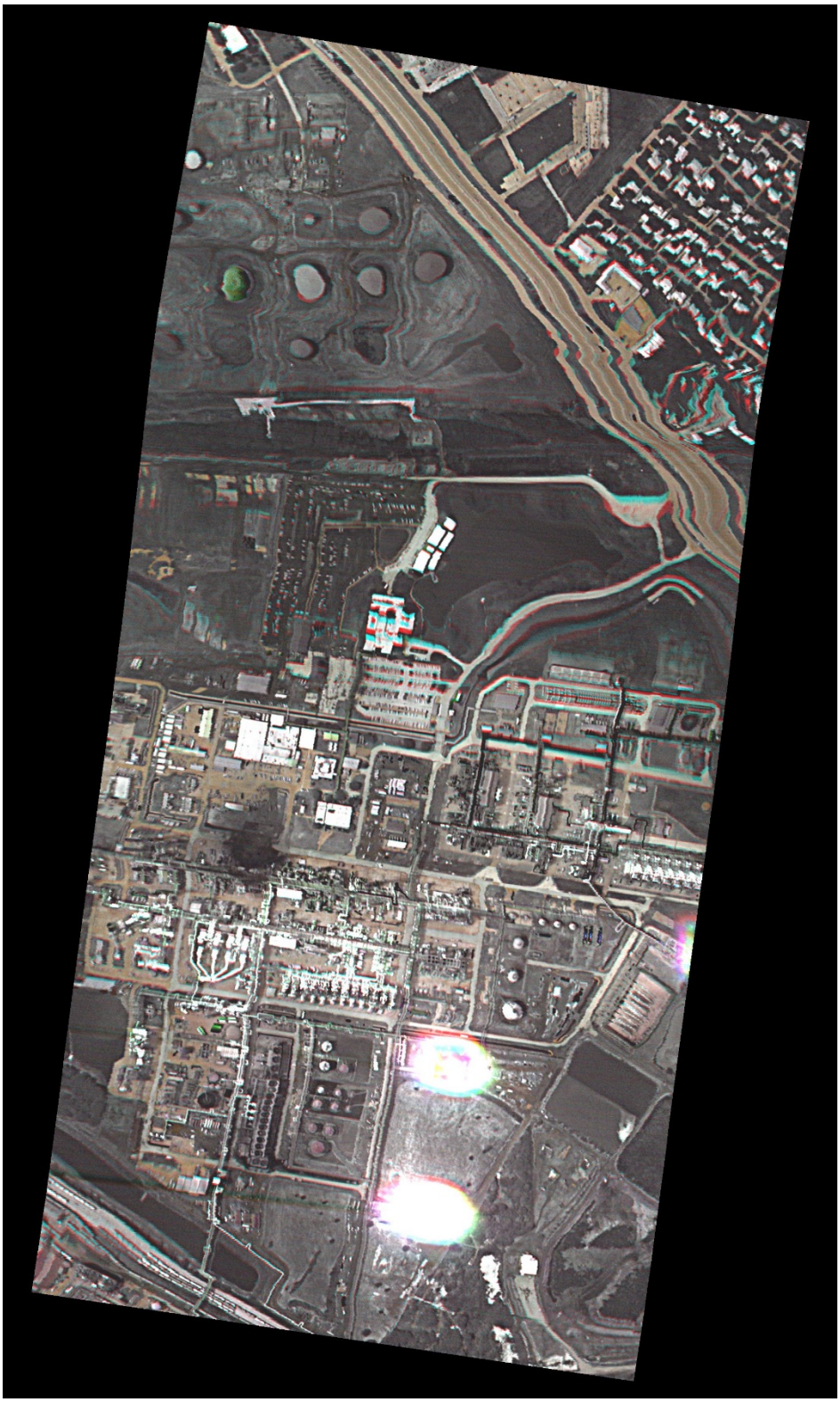

Figure 3: – 3 band IR image, ExxonMobil Baytown Fire, Pass 2

FTIR Data Results

FTIR Spectral data at a resolution of 16 wavenumbers was collected for each pass. ASPECT uses an automated detection algorithm to permit compounds to be analyzed while the aircraft is in flight. 72 compounds are included in this algorithm and the list and associated detection limits are given in Table 2. In addition, collected data are also manually analyzed by comparing any detected spectral signatures to a collection of published library spectra. No detections were made on any of the data collection passes.

TABLE 2 - Chemicals Included in the ASPECT Auto-Processing Library

Acetic Acid	Cumene	Isoprene	Propylene
Acetone	Diborane	Isopropanol	Propylene Oxide
Acrolein	1,1-Dichloroethene	Isopropyl Acetate	Silicon Tetrafluoride
Acrylonitrile	Dichloromethane	MAPP	Sulfur Dioxide
Acrylic Acid	Dichlorodifluoromethane	Methyl Acetate	Sulfur Hexafluoride
Allyl Alcohol	Difluoroethane	Methyl Ethyl Ketone	Sulfur Mustard
Ammonia	Difluoromethane	Methanol	Nitrogen Mustard
Arsine	Ethanol	Methylbromide	Phosgene
Bis-Chloroethyl Ether	Ethyl Acetate	Methylene Chloride	Phosphine
Boron Tribromide	Ethyl Formate	Methyl Methacrylate	Tetrachloroethylene
Boron Triflouride	Ethylene	MTEB	1,1,1-Trichloroethane
1,3-Butadiene	Formic Acid	Naphthalene	Trichloroethylene
1-Butene	Freon 134a	n-Butyl Acetate	Trichloromethane
2-Butene	GA (Tabun)	n-Butyl Alcohol	Triethylamine
Carbon Tetrachloride	GB (Sarin)	Nitric Acid	Triethylphosphate
Carbonyl Chloride	Germane	Nitrogen Trifluoride	Trimethylamine
Carbon Tetraflouride	Hexafluoroacetone	Phosphorus Oxychloride	Trimethyl Phosphite
Chlorodifluoromethane	Isobutylene	Propyl Acetate	Vinyl Acetate

Table 3. Chemical Results Summary

Run	Date	Time (UTC)	Chemical	Max Concentration ppm
1	31 July 2019	2049	Test	Test
2		2113	ND	None
3		2117	ND	None
4		2122	ND	None
5		2127	ND	None
6		2131	ND	None
7		2137	ND	None
8		2142	ND	None
9		2146	ND	None
10		2208	ND	None
11		2226	ND	None
Note: ND = No Detections				

Aerial Photography Results

A full set of high resolution aerial digital photography were collected as part of the flight. Figure 4 shows a representative image collected as part of each pass. Examination of the image shows two firewater streams being sprayed on the unit in the lower right quadrant of the image. The frame illustrates that the fire was extinguished and was generating no significant visual plume at the time of the image collection.

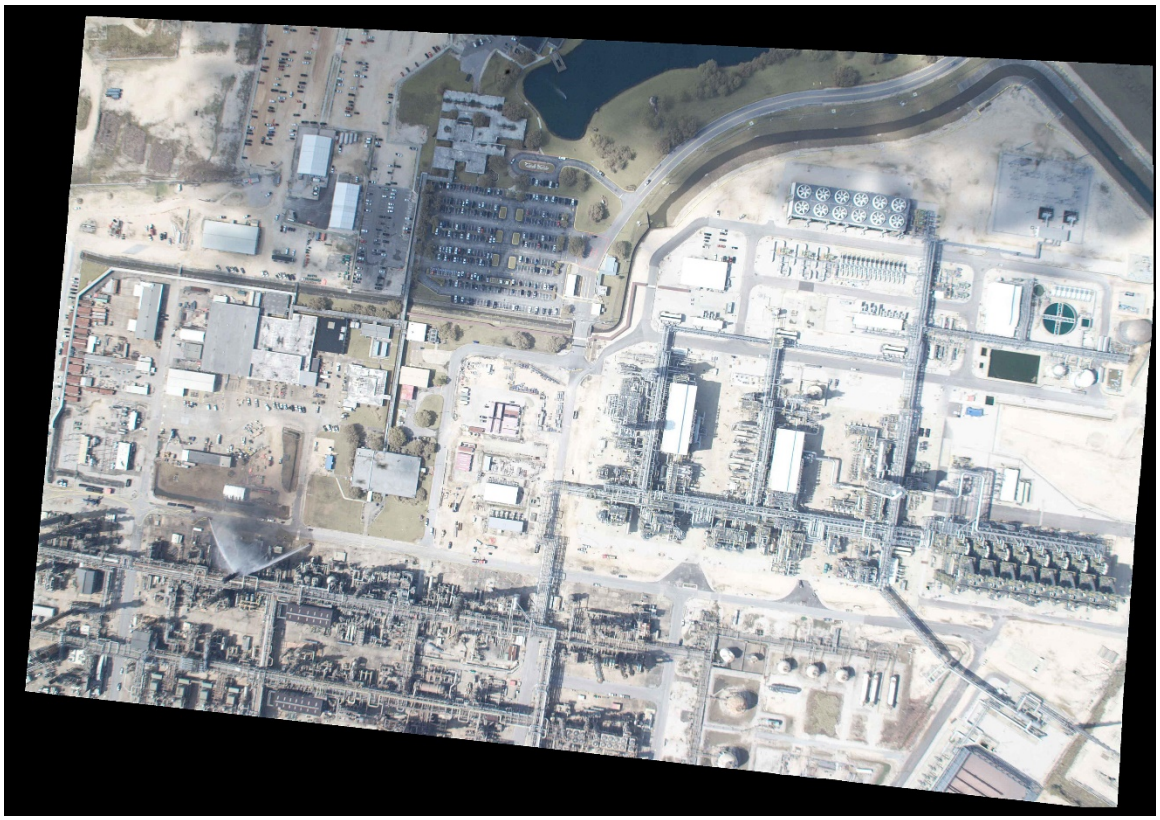

Figure 4: Aerial Image of the ExxonMobil Baytown Fire

Conclusions

On 31 July 2019 ASPECT was dispatched to collect aerial remotes sensing data over the ExxonMobil facility located in Baytown, TX. An explosion and fire involving an olefin unit was reported (via media) shortly after 1100. ASPECT was reported to be over the site at 1613 and collected a total of 11 passes. No detections were noted on any of the passes. Two factors may have influenced the absence of detectable compounds with the first being the fact that the fire was extinguished at about the time that ASPECT was setting up for the first pass. Likewise, it is also possible that any residual plume

would have been hard to detect since the aircraft was consistently flown several hundred meters downwind of the unit. Irrespective, the results of this collection do show that no detectable compounds were observed departing the facility boundaries.

Appendix A

Abbreviations:

DEM – Digital elevation model
Alt – Altitude (in feet)
MSL – Mean sea level altitude (in feet)
Digital – Digital photography file from the Nikon D2X camera
MSIC – Digital photography file from the Imperx mapping camera
FTIR – Spectral IR data collected with a Fourier Transform Infrared Spectrometer
IRLS – Infrared Line Scanner
Jpg – JPEG image format
UTC – Universal Time Coordinated
img – Spectral data format based on Grams format

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Mission:   2019-07-31 ExonMobil Refinery Fire

Date:      7/31/2019
Time UTC: 20:39

Aircraft Number: N9738B
Pilot: Todd Seale
Copilot: James Glaviano
Operator: James Crisp
Aft Operator: Gerry Broyles
Ground Controller: Ahmed Hafez

DEM: Using elevation from DEM Database
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Run: 1 Time: 20:49:38 UTC
        Alt: 3056 ft MSL  Elev: 376 ft  Elevation from DEM Database
        Vel: 162 knots  Heading: 157

Digitals:  None
MSIC: 3
        20190731204944534.jpg
        20190731204950883.jpg
        20190731204957233.jpg
FTIR: 1
        20190731_204941_A.igm
IRLS: 1
        2019_07_31_20_49_42_R_01 TA=29.0;TB=49.0;Gain=3
Gamma Runs:  None

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Run: 2 Time: 21:13:28 UTC
Alt: 2964 ft MSL Elev: 18 ft Elevation from DEM Database
Vel: 122 knots Heading: 186

Digitals: None
MSIC: 6
20190731211334439.jpg
20190731211340805.jpg
20190731211347154.jpg
20190731211353503.jpg
20190731211359868.jpg
20190731211406217.jpg
FTIR: 1
20190731_211332_A.igm
IRLS: 1
2019_07_31_21_13_32_R_02 TA=23.1;TB=43.1;Gain=3
Gamma Runs: None

Run: 3 Time: 21:17:08 UTC
Alt: 2769 ft MSL Elev: 18 ft Elevation from DEM Database
Vel: 121 knots Heading: 219

Digitals: None
MSIC: 7
20190731211714158.jpg
20190731211720507.jpg
20190731211726856.jpg
20190731211734126.jpg
20190731211740475.jpg
20190731211746839.jpg
20190731211749554.jpg
FTIR: 1
20190731_211710_A.igm
IRLS: 1
2019_07_31_21_17_12_R_03 TA=22.3;TB=42.3;Gain=3
Gamma Runs: None

Run: 4 Time: 21:22:07 UTC
Alt: 2944 ft MSL Elev: 18 ft Elevation from DEM Database
Vel: 119 knots Heading: 214

Digitals: None
MSIC: 6
20190731212213751.jpg
20190731212220115.jpg
20190731212226472.jpg
20190731212232821.jpg
20190731212240079.jpg
20190731212246434.jpg

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FTIR: 1
        20190731_212211_A.igm
IRLS: 1
        2019_07_31_21_22_12_R_04 TA=23.0;TB=43.0;Gain=3
Gamma Runs:  None

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Run: 5 Time: 21:27:18 UTC
        Alt: 2882 ft MSL  Elev: 19 ft  Elevation from DEM Database
        Vel: 111 knots  Heading: 209

Digitals:  None
MSIC: 6
        20190731212724261.jpg
        20190731212730610.jpg
        20190731212736959.jpg
        20190731212744228.jpg
        20190731212750577.jpg
        20190731212756942.jpg
FTIR: 1
        20190731_212721_A.igm
IRLS: 1
        2019_07_31_21_27_22_R_05 TA=23.0;TB=43.0;Gain=3
Gamma Runs:  None

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Run: 6 Time: 21:31:53 UTC
        Alt: 2896 ft MSL  Elev: 18 ft  Elevation from DEM Database
        Vel: 107 knots  Heading: 218

Digitals:  None
MSIC: 6
        20190731213159340.jpg
        20190731213206610.jpg
        20190731213212959.jpg
        20190731213219323.jpg
        20190731213225673.jpg
        20190731213232022.jpg
FTIR: 1
        20190731_213156_A.igm
IRLS: 1
        2019_07_31_21_31_58_R_06 TA=23.0;TB=43.0;Gain=3
Gamma Runs:  None

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Run: 7 Time: 21:37:43 UTC
        Alt: 2911 ft MSL  Elev: 18 ft  Elevation from DEM Database
        Vel: 114 knots  Heading: 200

Digitals:  None
MSIC: 9
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        20190731213749794.jpg
        20190731213756142.jpg
        20190731213802507.jpg
        20190731213808852.jpg
        20190731213815217.jpg
        20190731213821570.jpg
        20190731213827919.jpg
        20190731213834268.jpg
        20190731213837903.jpg
FTIR: 2
        20190731_213746_A.igm
        20190731_213826_A.igm
IRLS: 1
        2019_07_31_21_37_48_R_07 TA=22.5;TB=42.5;Gain=3
Gamma Runs:  None

-------------------------------------------------------------------

Run: 8 Time: 21:42:45 UTC
        Alt: 2846 ft MSL  Elev: 18 ft  Elevation from DEM Database
        Vel: 111 knots  Heading: 201

Digitals:  None
MSIC: 4
        20190731214251214.jpg
        20190731214257563.jpg
        20190731214303928.jpg
        20190731214310277.jpg
FTIR: 1
        20190731_214248_A.igm
IRLS: 1
        2019_07_31_21_42_49_R_08 TA=23.3;TB=43.3;Gain=3
Gamma Runs:  None

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Run: 9 Time: 21:46:57 UTC
        Alt: 2523 ft MSL  Elev: 18 ft  Elevation from DEM Database
        Vel: 99 knots  Heading: 211

Digitals:  None
MSIC: 5
        20190731214703603.jpg
        20190731214709952.jpg
        20190731214716316.jpg
        20190731214722666.jpg
        20190731214729030.jpg
FTIR: 1
        20190731_214701_A.igm
IRLS: 1
        2019_07_31_21_47_02_R_09 TA=24.5;TB=44.5;Gain=3
Gamma Runs:  None

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```

Run: 10 Time: 22:08:60 UTC
Alt: 2954 ft MSL Elev: 18 ft Elevation from DEM Database
Vel: 99 knots Heading: 189

Digitals: None
MSIC: 3
20190731220906412.jpg
20190731220913666.jpg
20190731220920021.jpg
FTIR: 1
20190731_220904_A.igm
IRLS: 1
2019_07_31_22_09_05_R_10 TA=25.8;TB=45.8;Gain=3
Gamma Runs: None

Run: 11 Time: 22:26:17 UTC
Alt: 3018 ft MSL Elev: 19 ft Elevation from DEM Database
Vel: 105 knots Heading: 205

Digitals: None
MSIC: 5
20190731222623226.jpg
20190731222629575.jpg
20190731222635940.jpg
20190731222642289.jpg
20190731222646838.jpg
FTIR: 1
20190731_222619_A.igm
IRLS: 1
2019_07_31_22_26_21_R_11 TA=24.2;TB=44.2;Gain=3
Gamma Runs: None

Mission Complete: 22:31 (UTC)