UAV / Drone Uses in the Petroleum Industry
Upstream Focus
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AAPG
Oil and Gas Exploration:
Site Surveys / Building Locations

Quarry survey: example of surveying in rugged terrain, such as in the Marcellus / Utica [http://futureaerial.com/press/]
Surveying for Seismic Surveys

3D Model Pointcloud Mapping Orthophoto (Skeye UAV survey)
https://www.youtube.com/watch?v=yXdqMBR2Kd8
Oil and Gas Exploration: Surface Geochemistry

- Surveys to detect methane seeps
- Combine with surface geochemistry
- Identify serpentinite plugs, Niagaran reefs, more.
Upstream: Methane Detection

Boreal – fixed wing with onboard analyzer
Upstream: Methane Detection

Boreal – fixed wing with onboard analyzer
SDR-Based Ground Penetrating Radar

- Onboard computer Intel Core i7 processor
- High-level and low-level processor
- IMU, GPS, camera

**USRP B210 Ettus board**
- GNU radio
- SDR (FPGA processor)

**Optical sensor**
- Altimeter accuracy ±0.025m

**TX antenna**

**RX antenna**

**Vivaldi antipodal antennas**
- Bandwidth 1.5 - 9GHz
- SMA connection to USRP

Landmine detection, but also used in conjunction with seismic surveys; Along active faults, possible additional uses such as avoiding utility services, etc.
Environmental Applications

3D water capacity study
https://themappingnetwork.wordpress.com/2017/03/16/drone-and-sonar-to-create-elevation-contours-draft/

Many environmental applications
• Spills
• Water depth
• Fires
• Flooding
• Depth of lakes / rivers / arroyos
Calculating Volumes: How much water can the reservoir hold?

Environmental geology uses: Dow Geospatial
Workhorse Quadcopters

Flexible enough and of low enough cost for new kinds of surveys:

- Coastal erosion
- Offshore hazards
- Inspecting facilities

DJI PHANTOM 4

Widely used in spite of data processing limitations:
When cost & response times are the key

NOTE: DJI is usually not used for more specialized applications
Best Flight Time Quadcopters

**Parrot Bebop 2**  
$\text{25 min } 3200 \text{ meters}$  
Parrot has doubled the battery life from earlier versions, and is designed for easy transport with its compact size. You can use third-party Bluetooth controllers. While it only has 8GB of internal storage, with Bluetooth, you can upload directly to the cloud.

**3DR Solo**  
$\text{22 min } 500 \text{ meters}$  
Users love the controls, and also the high-quality video for the price. This is a stable drone, and although it may not hold a charge as long as the others, batteries easy to charge, and they are reasonably priced.

**Yuneec Q500+**  
$\text{22 min } 2000 \text{ meters}$  
Although it’s on the low range of flight time, it’s big and not as affected by wind. It has a number of built-in systems, such as integrated aerial and ground imaging, which will make your 3D graphics really pop. Because of its stability, the videos are smooth, and the colors are gorgeous.
# Cameras for Drones

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<tr>
<th>Camera</th>
<th>Megapixels</th>
<th>Compatibility</th>
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<tr>
<td>DJI Zenmuse XT Thermal (FLIR)</td>
<td>640/30 fps</td>
<td>DJI Zenmuse XT</td>
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Thermal Sensors and Upstream

Thermal variations can lead to heat flow

New ideas:

• Surface heat flow mapping linked to active faults
• Geothermal halos
• Methane seeps can be tied to thermal images (direct hydrocarbon indicators)

DJI Zenmuse XT FLIR Thermal Camera
Methane Sensors

- Cavity ring-down spectroscopy (CRDS) in Colorado State University Ventures
- Optical sensors (Draco Scientific)
- Longwave infrared thermal sensor (FLIR Quark 640)
- Miniature NASA Sensor technology (SeekOps)
- Laser-based sensor (Boreal)
- Integrated drone / sensor (Raven – GE Research)
- Laser methane detector (Pergam)
Best 3D Imaging Software

**DroneDeploy:** Cloud-based, integrates with DJI Phantom 4, georeferenced, orthorectified orthomosaics, topographic modeling (terrain), crop health visualization (Normalized Difference Vegetation Index - NDVI analysis), 3D models and point clouds.

**Pix4D:** Photogrammetry software that uses drone-derived images to generate point clouds, digital surface and terrain models, orthomosaics, textured models, and more.

**Datumate:** Focus on civil engineering and construction. Point clouds, progress report imaging, project management.

**ENVI:** a platform that allows proprietary algorithms, integrates with ArcGIS, and supports multi and hyperspectral, LiDAR, SAR, and FMV. Offers cloud-based desktop software, for photogrammetry and feature extraction module.
Using Drones to Improve Reservoir Characterization

Recognize that it is a multi-step process, and you can use a combination of photogrammetry, LIDAR and thermal

https://uni.no/nb/topics/virtual-outcrop-geology/
Digital Outcrops and Seismic Geomorphology

Seismic Geomorphology
Pattern Recognition in Multiple Domains

Cretaceous Ferron Sandstone, Utah

www.stratigraphyhelp.com

Having observed clinoforms in several ancient deltaic successions experience anticipates the presence of channels at the top of this package – not the channel in the outcrop photo above.
Using Drones to Improve Reservoir Characterization

Obtain create high-resolution digital outcrop images for both 3D and 2D rendering
Using Drones to Improve Reservoir Characterization

Multiple methods of processing your data
Digital Outcrop Model

Develop a digital outcrop model and identify the formations and facies
Using Drones to Improve Reservoir Characterization

Bring in seismic in areas where the same formations occur in the subsurface
Using Drones to Improve Reservoir Characterization: Modifying Your Workflow

Create a workflow to accommodate the data you have

Focus on your desired outcome
Reservoir Characterization

-- Integrate and connect your data sets
-- Create models
-- Tie to other data sets (porosity / permeability)
-- History matching
Integrating the Digital Outcrops

The goal: better images / views – more accurate reservoir models
Galaxy Unmanned Airships (mini-blimps)

- Longer flight times (8 hours)
- Stable for sensors requiring little movement
- Heavier payload (LIDAR, gravity-magnetic, etc.)

Stable, long flight time, heavy payloads