A Case History on the Development and Application of UAV-MAG™ to Mineral Exploration
Forward Looking Statement

Statements in this presentation, other than purely historical information, including statements relating to the Company’s future plans and objectives or expected results, may include forward-looking statements. Forward-looking statements are based on numerous assumptions and are subject to all of the risks and uncertainties inherent in technology, research and development. As a result, actual results and forecasts may vary materially from those described in the forward-looking statements.
A summary of the development and success of the UAV-MAG™

• Why UAV’s – A pivotal decision for Pioneer
• Survey System goals & specs
• Research and development
• Safety
• Productivity
• Data quality
• Survey Examples
• Industry adoption & future of UAV-MAG™
Why UAV’s – A Pivotal decision

• First UAV acquired in 2014
  • Multicopter – Photogrammetry
  • Orthophotos
  • DEM
  • Volume Calculations
  • *Added Value Services

Pioneer Aerial Surveys Ltd. - a Global UAV Company CSE:UAV © 2017
Digital Elevation Model of gravel quarry at centimeter scale accuracy

One Day
1000+ photos
DGPS GCP’s
Survey System – Goals & Specs

Recognized a demand for UAV based geophysics
    • Platform Choice

Rotary VS Fixed Wing
    • Remote surveys
    • Easy transport
    • Safe takeoff and landing in any terrain
    • High payload & endurance
    • Small crew operations

Next Step: R&D
UAV-MAG™ Research and Development

• First UAV acquired in 2014
  • Sufficient payload
  • Sufficient range
  • Limited endurance
UAV-MAG™ Research and Development

- A focus on data QUALITY
  - Noise and interference testing
  - Sensor flight characteristics
  - Rugged reliability

Solutions: UAV-MAG™
- MAG Sensor to Craft separation distance
- Specially designed stiff/flexible cable
- Durable design and components

Success: First survey flown in Fall 2014
- 650 line km, rugged mountain & forested terrain
UAV-MAG™
Advancement in geophysical survey technology

Flight System Specs:
Coaxial Multi-Rotor

- 2-3 Kg Payload
- 12 min Flight Time
- Full Autonomous Flight
- Simple mission pre-plan
- Accurate altitude & Waypoint flight
- High (40km/h) wind tolerance
- Easily transportable - Anywhere
- Up to 75 Line Km/ day

RESOLUTION = COST
Safety – Increasing the margin

• Field based exploration has risks
  • Slips, trips, falls
  • Fatigue, weather
  • Wildlife and environment

UAV’s offer a real solution for safety
• Safe landing and takeoff areas
• Limited off track hiking
• Low physical stress
• Less exposure to all risks
• UAV-related risks are controllable
Productivity & Cost – A comparison

**Walk Mag**
- 5-8 hours
- 3-15 km
- Low MOB
- Low standby costs

$\\$\\$$/ Line km
0-200 Line km

**UAV-MAG™**
- Day/Night flights
- 100+ line km per day
- Low MOB
- Low Standby
- High weather tolerances
  (wind / ceiling)

$-\\$$ / Line km
Up to 1000 to 2000 Line km

**Airborne Mag**
- 1000 km per flight
- High MOB
- High Standby
- Low weather tolerances

$ / Line km
1000+ Line km
Data Quality – All or Nothing

**Mag Sensor Specs:**

*GEM Systems & Pioneer Exploration Consultants*

- **Weight:** 1.0 kg
- **Sensitivity:** 0.0003 nT @ 1 nT
- **Heading Error:** + / – 0.05 nT 360 degrees full rotation about axis
- **Resolution:** 0.0001 nT
- **Absolute Accuracy:** +/- 0.05 nT
- **Sampling Rate:** 10, 20 Hz (higher optional)
- **Sensor Orientation:** optimum angle 35 degrees between sensor head axis and field vector
Data Quality – All or Nothing

How Does UAV-MAG™ data compare?

[Graph showing data comparison]
High Resolution Survey Comparison on a shear hosted gold deposit

UAV-MAG™
15m line spacing

Gold Deposit

100m line spacing
Case Examples—Cu Porphyry

Total Field RTP 6 flight days 377 line km. 50m line spacing, 50m AGL
Case Examples – Oman Copper & Chromite
Multi-Elevation UAV-MAG™ Surveys

Survey flights flown over the same target at different elevations increase resolution considerably over conventional airborne survey methods.

South Oman Copper Deposit

- Two historic mine sites were covered in a survey of approximately 1 km$^2$
- 4 flights, 20m line spacing
- High resolution: <50cm ground sampling
- Distinct mag anomalies identified which are associated with Cr mineralization on the ground. **Combined survey results reveal sharp targets coincident with mineralization**

2 surveys
- 20m AGL & 60m AGL

Pioneer Aerial Surveys Ltd. - a Global UAV Company CSE:UAV © 2017
South Oman Copper Deposit

- Three historic mine sites were covered in a survey of approximately 1 km²
- 6 flights, 50m line spacing
- High resolution: <1m ground sampling
- Distinct mag anomalies identified which are associated with Cu mineralization on the ground.
Oman Copper UAV-MAG™ Survey
Results

1st Vertical Derivative RTE

Horizontal Derivative RTE
Case Examples– Kimberlite & Lamprophyre

Total Field RTP 10 flight days 650 line km. 50m line spacing, 50m AGL

© 2017
Pioneer Exploration has surveyed around the world over 3000 line km of UAV-MAG™ since 2014.

Survey Locations Flown to date
70% Major Mining Companies
30% Jr’s & Private

Canada
- Yukon
- Saskatchewan
- Ontario
- Nunavut
- British Columbia
- Quebec

USA
- Montana
- Kansas
- Arizona
- Colorado
- Nevada
- Hawaii

Global
- Sultanate of Oman
- Chile
Industry Adoption & UAV-MAG™ Survey Future

Strong & rapidly growing industry interest for a niche service

2014 - 1 Survey - Private Co.
2015 - 3 Surveys – Jr Mining Co, Govt
2016 - 8 Surveys – Major, Jr & Private Mining Companies
2017 - 15+

Customer Emphasis on Safety & Quality
Excellent feedback & Repeat Clients

Room for Continued improvement
• UAV Platform
• Sensor Design & operation
• Regulations - BVLOS
3 Key Factors for Future Progress

1. Improvements in Technology from Developers and Service Providers
2. Bringing proven high quality data solutions to the market, not concepts
3. Keeping Reality in check – Economy, Efficiency, Safety