www.mpx.com	www.sumecgeopower.ch www.sumec.com	www.lomina.ch

METHOD	**PTEM and AEM-PTP** **Passive Airborne Electromagnetic Survey System**	
Method Range	**Method reliability**	**Method cost per s.q.km**
> 7.000m	50-80%	80.000 eur
Application Phase	**Advantages**	**Disadvantages**
- INITIAL - PLANING	o Low cost o Innovative method o Aerial = not requiring ground permit o Fast response	o Sensitive on external interference o Relatively lower reliability

THE PINEMONT AEM-PTP PASSIVE AIRBORNE ELECTROMAGNETIC

WHY CONDUCT AN AEM-PTP SURVEY?

Conducting AEM-PTP surveys will provide a range of benefits to your exploration efforts:

- The identification of areas of higher E-field transient density help to provide focus as well as identify promising areas for further exploration. Higher levels of E-Field transient density are often associated with REDOX cells created by upward fluid flow associated with outgassing and fluid migration pathways.
- Anomalies can be compared to the response over known analogue fields to help calibrate and rank leads and prospects.
- The survey equipment is very portable and can be easily configured within most aircraft.
- Data collected can be independent and may be complimentary to all other airborne datasets.
- This survey technique is a simple, fast and cost-effective means of fulfilling airborne work commitments.
- The AEM-PTP system can be configured with other sensors to conduct multi-sensor surveys (e.g. magnetics and gravity).

AEM-PTP - SCIENTIFIC BACKGROUND

Many authors have documented examples of data collected over numerous oil and gas fields concluding that all fields are in a continuous state of depletion through leakage allowing for a continuous saturation of seals (Kontorovich, 1984) (Schumacher & Abrams, 1996) (Schumacher & LeSchack, 2002). This upward fluid flow of hydrocarbons in the form of micro seepages has been well documented and is described by most authors using the REDOX model.

Professor Silvain J. Pirson (Pirson, 1970) demonstrated oil related reduction-oxidation cells (REDOX) using SP base line shifts relative to subsurface production zones. Pirson also introduced the model that oil field REDOX cells behaved like large weakly charged batteries moving limited amounts of current to the surface (USA Patent No. US3943426A, 1974). Experimentally, Pirson (1981) and later Reed (1990) demonstrated that when shale cuttings are immersed in oil, reduction occurs generating a negative charge. This natural cracking process continues as long as fresh oil is available.

While the occurrence of hydrocarbon-induced geophysical, geomicrobial and geochemical alteration associated with hydrocarbon accumulations is now well established, our current understanding of the many factors affecting the formation of these alteration zones in the subsurface is incomplete. Consequently, methods for REDOX identification remain underutilized.

Pinemont's AEM-PTP passive airborne magnetic impulse survey exploits aspects of these alteration zones by measuring increases in electromagnetic energy when naturally occurring transient impulses interact with elements of these REDOX cells.

When a battery (e.g. REDOX cell) is placed in the presence of a magnetic field (e.g. Earth's magnetic field), an electromotive force is generated as described by Lorentz's force law. This interaction between battery and magnetic field was first demonstrated by Michael Faraday in 1821 to the London society and now known as the Homopolar motor. Many examples demonstrating a modern version of the Homopolar motor can be found on the internet (YouTube, 2014).

The AEM-PTP technology was developed to measure variability in the earth's passive electromagnetic field either at the earth's surface or from low-flying aircraft. Vertical components of this field contain transient impulses of energy varying across a wide frequency range, including the audio range.

When these impulses interact with REDOX cells, like those created by vertical fluid flow such as hydrocarbon micro-seepage, there is a measureable increase in the density of these transients. It is this increase in transient density which we are trying to measure (*Figure 1*Figure).

In summary, Pinemont Technologies' AEM-PTP system measures the geophysical response (increased transient density) of REDOX cells. In an airborne survey configuration, an aircraft flying low (120m to 150m) and slow (~120 knots) collects transient activity via an E field antenna. In the presence of a REDOX cell, higher densities of transient impulses are measured.

Since REDOX cells are not unique to outgassing hydrocarbon accumulations, REDOX activity can also be used to help identify upward fluid flow associated with migration pathways responsible for hydrocarbon charge hydrothermal mineralization and geothermal up flow.

This passive apparent resistivity method developed by Pinemont Technologies Inc. incorporates methodologies similar to those described in the AFMAG technique developed by Mr. S.H. Ward (Ward, 1959). The proprietary system Pinemont has developed based upon Pinemont's Australian patent (2005202867) can be conceptually considered as an E field adaptation of AFMAG. This passive system records E field activity over a range of Extremely Low Frequencies (ELF). Although a "unifying theory" has yet to be postulated, empirical evidence points to Airborne Transient Pulse Surveys as being a most valuable reconnaissance exploration tool.

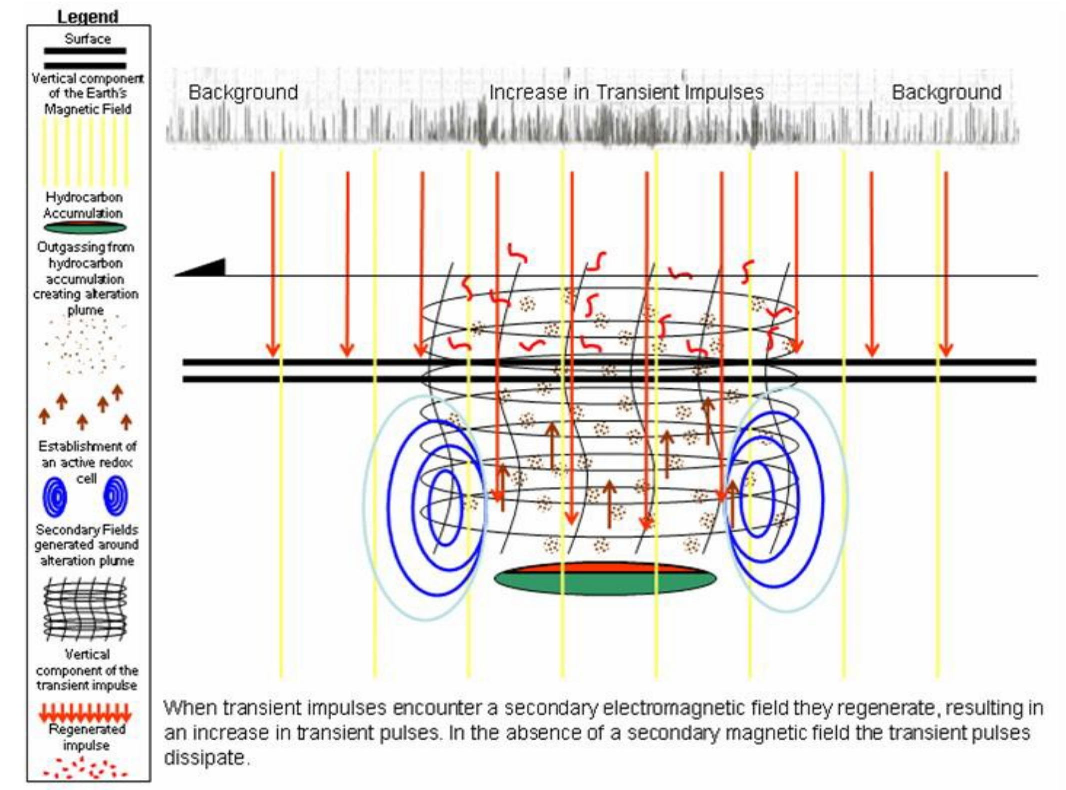


*Figure 1- **Schematic of the impact REDOX cells have on the transient impulses detected in the Earths E-field.***

WHY MEASURE REDOX ACTIVITY?

The detection of transients of secondary electromagnetic fields associated with upward fluid flow associated with REDOX activity. REDOX cells are known to form in under the following conditions:

- Micro-seepage plumes above hydrocarbon accumulations.
- Migration of fluids associated hydrocarbon charge.
- Migration of hydrothermal fluids associated to minerals deposits (i.e. Carlin Style Gold deposits, Lead-Zinc, Uranium, Geothermal fluids.

TECHNOLOGICAL ADVANCES- PTEM AND AEM-PTP

Pinemont's AEM-PTP system is an upgrade to the original P-TEM system (USA Patent No. 6937190 B1, 2003) now recording ten frequency bands compared the original single band P-TEM system (*Figure 2*).

AEM-PTP measures from an airborne platform apparent conductivity as a function of depth in the earth. We note that the higher the conductivity of any given horizon, the fewer the number of transient pulses emanating from that horizon.

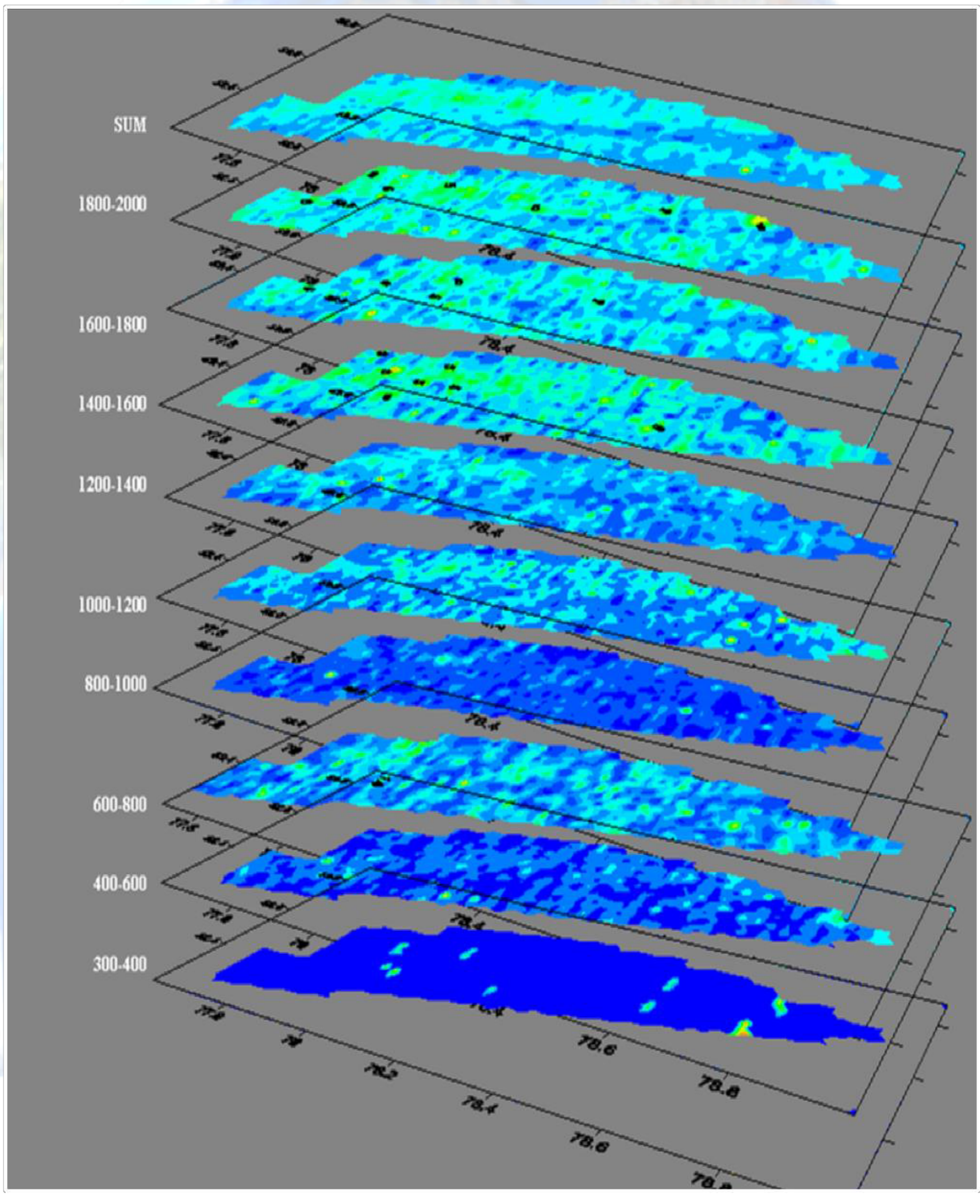


Figure 2- Schematic diagram showing the different frequency range components taken during an AEM-PTP survey.

AIRBORNE AEM-PTP SURVEYING

Pinemont Technologies method of measuring transient density is a breakthrough, in terms of the compact nature of the equipment (order of magnitude reduction in weight and footprint).

Figure 3- View from the airplane during an AEM-PTP survey

Typical AEM-PTP surveys are flown at an altitude of 100m above ground or water surface, and at a speed of between 80 - 100 knots (150 - 185 km/hour) in a fixed-wing aircraft or 60 - 80 knots (110 – 150 km/hr) in a helicopter. Both light planes and helicopters may be used as survey platforms (*Figure 3*). The light-weight portable sensing equipment and antenna are carried entirely within the aircraft. It does not matter if the airframe is made of aluminium or not; transient pulse signals are not attenuated either way. Cultural artefacts on the ground, such as, wells, pipelines, utility lines, etc., have no effect on data quality. Flight line spacing is determined based on the size of the expected prospects. The AEM-PTP technology works well in both onshore and offshore environments.

Figure 4: The fixed-wing (Cessna 182) and helicopter (Bell 206B3 Jet Ranger) platforms that may be used for these surveys

Additional information, examples and references can be found in two papers presented as AAPG papers (LeSchack & Jackson, Airborne Measurement of Transient Pulses Locates Hydrocarbon Reservoirs, 2006) and (LeSchack, Jackson, Dirstein, Ghazar, & Ionkina, 2010).

FREQUENCY TO DEPTH EMPIRICAL CALIBRATION

Pinemont founder and inventor John R. Jackson published a frequency depth relationship based upon observational data relating inherent frequency of the pulse energy to the depth beneath the surface from which the pulses emanated (USA Patent No. US6087833 A, 1998). While a frequency depth relationship has been published, validation and calibration known analogues is always recommended (*Figure*).

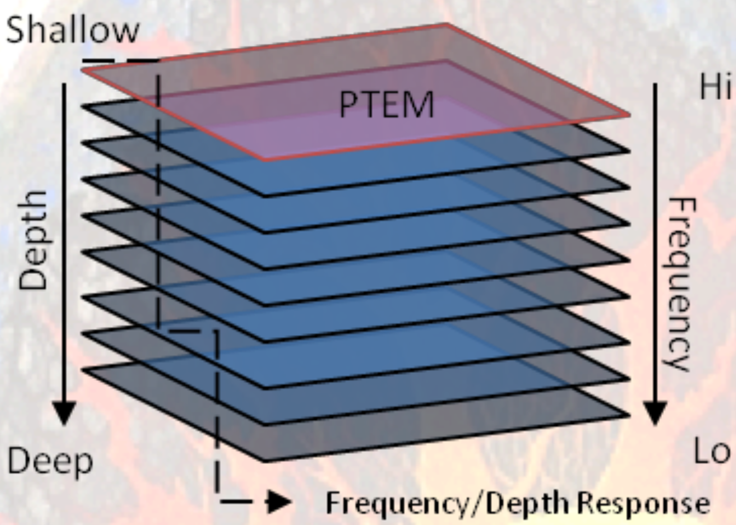


Figure 5: New AEM-PTP survey method showing the relationship between frequency and depth.

PASSIVE GEOPHYSICAL AIRBORNE SURVEYS

All geophysical acquisition systems collect data that identifies measurable changes to help define boundaries and domains within the collected data to help create a model of the zone of interest.

While AEM-PTP, Magnetics and Gravity are all passive potential field techniques, they all have one element that is common to every geophysical technique, non-uniqueness. This non-uniqueness means that more than one solution can fit the data. The best way to address non-uniqueness is to combine a variety of different (and more importantly independent) technologies to minimize the number of solutions that can fit the suite of datasets.

For example a magnetics survey may reveal boundaries and lineaments that help to identify different structural domains in the subsurface which when calibrated provide insights into the nature of the underlying rocks. Similarly, data from a Gravity survey may provide an indication of structural geometries (highs and lows) and sediment thickness based on assumptions about modeled rock densities and geometries. Therefore, gravity and magnetics helps to provide information about the location of structural elements such as faults, lineaments, intrusions and depth to basement.

Since Pinemont's passive system detects increased levels of transient activity associated with REDOX activity providing an indication of upward fluid-flow/charge the data collected is both supplementary and complimentary to magnetics and gravity. Together, in frontier areas flown as a multi-sensor survey the combined techniques can provide a cost-effective means of collecting information about structure, fluid flow and charge. In more established exploration areas (with a high density of seismic data and ship board magnetics and gravity), an AEM-PTP can help rank prospects with respect to other hydrocarbon occurrences in the area.

DATA ACQUISITION

Survey Area(s)

As discussed above no area for the testing has yet been designated by Client, however, we expect that these tests will be undertaken over blocks yet to be designated, in Slovakia or Czech Republic. These test areas should be in the order of 8 to 10 km² each. If flown with a grid of lines spaced 1,000 metres apart then each block would comprise approximately 40 to 50 line-km of data acquisition. The data acquisition of one such small survey blocks will likely take 1 to 2 days to complete, and some 2 to 3 hours of helicopter flight time.

Base of Operations

The main base of operations for the project will be chosen once the test areas have been selected.

Survey Lines

The survey lines are normally spaced 700 metres to 1,000 metres apart, in an east – west orientation. Data will be acquired in drape mode, at a survey height of 100m above the ground.

Aircraft

The survey can be flown with either a fixed-wing aircraft, or a helicopter, depending on the ruggedness of the terrain over which the survey will be flown. However, we understand that the Client will provide a helicopter for this test flying, likely to be a Robinson R44 or Bell 206B3 model.

Figure 6: A Bell 206B3 Jet Ranger helicopter

Survey Equipment

The Survey Equipment consists of a laptop computer, antenna and Bluetooth GPS unit which are situated on the backseats of the aircraft (*Figure 7*). A yoke mounted Garmin 296 GPS is placed with the pilot.

Figure 7: The AEM-PTP survey equipment to be installed in the aircraft

1) The GPS Units

On board the aircraft there are several GPS units independently calculating the aircrafts position using satellite derived co-ordinate information. The information is transferred to the onboard computer in real time during operations to accurately monitor the survey location.

2) The Antenna

The Earth's passive E-field response is recorded by the Antenna. The recorded signal parsed pulse frequency data is transferred to the laptop computer.

3) The Computer - DSP Data Acquisition

The onboard computer processes the parsed pulse frequency data into segregated bands, representing indicative depths (*Figure 8*). The fuller each bin, the more recorded pulses per unit time and the less the conductivity. This pulse data is collected along with Latitude, Longitude, ground speed, and time. The top-right data bin on the screen is the summation of all the preceding bandwidth segments.

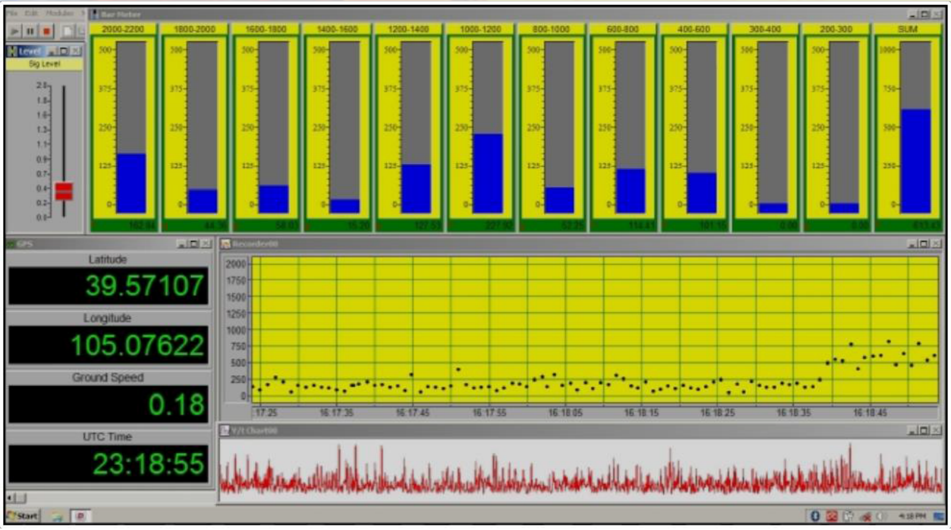


Figure 8- Onboard computer display.

In summary, the airborne system is a very portable (less than 5 Kg), cost-effective and an environmentally friendly exploration tool for applications that are both onshore and offshore. The acquisition system collects data in ten frequency bands providing an indication of depth of the increased transient activity. The resulting data is presented in terms of relative signal strength for a designated segment of the subsurface. GPS, UT Time, Date, and survey time are recorded simultaneously in the file.

DAILY TASKS

Overview of tasks that will be undertaken to complete field operations:

- On each fly day, the weather conditions are assessed and a decision is made as to whether to fly or not.
- A maintenance check is undertaken on the airplane to ensure that it is ready to fly.
- The survey equipment is tested and calibrated before operations begin.
- The best signal is usually collected shortly after sunrise until the early afternoon. After mid-day the signal-to-noise ratio drops as the ionosphere is becoming increasingly noisy.
- Data will be collected at an altitude of 100 metres above ground level at a ground speed of between 60 - 80 knots (110 – 150 km/hr) in the helicopter..
- Lines are usually flown E-W and W-E.
- Navigation will be provided using four separate GPS systems.
- Observation notes will be recorded by the onboard field engineer.
- The baseline recording level will be chosen and maintained by the onboard field engineer during operations. If baseline adjustments are required, the field engineer will go off-line. Once adjustments have been made the operator will loop back on-line and restart data collection.
- Return to the base airport and close operations for the day.
- The raw data collected will be reviewed by the onsite QC geophysicist and then sent to the Data Processing Centre for further QC and archiving.
- Preparation for the next day begins.

Q.C. OF SURVEY EQUIPMENT

The following steps are undertaken prior to conducting a survey to make sure that all the equipment is running correctly.

- Each day during equipment set-up a pre-survey test will be conducted to detect known interference or radio transmissions. All electronically actuated aircraft systems (gear, flaps, radios etc.) are cycled and tested for possible interference. Radio broadcasts are avoided during surveying. Survey lines will be repeated if a radio broadcast is necessary.

- Equipment will be tested for meteorological tolerances each morning before the commute to airport. Meteorological conditions and tolerances are monitored throughout the survey. The survey will be aborted if weather / meteorological conditions are not within tolerance.
- For QC purposes small preliminary surveys will be flown to check that the instruments are working correctly and to calibrate and optimize the equipment for the specific area.

QC OF SURVEY NAVIGATION

The following equipment will be used make sure the aircraft is flying over the correct airspace.

- Aircraft NavAids (GPS/VOR/ADF systems)
- Airspace Charts
- Survey equipment GPS's (Garmin 296, two-Bluetooth GPS's)

DATA RECORDING QC PROCEDURES

Multiple Quality Control assurances are in place to maintain a high quality and reliable standard of recorded data.

- During the acquisition phase the raw data being acquired is assessed on the onboard computer by the field engineer.
- At the end of each flying day the raw data will be sent to be processed.
- The raw data is plotted and examined (QC'd) for artifacts (i.e. spiking, surges or data inconsistencies), as well as areas of anomalous activity.
- If anomalous results/ artefacts are observed, this information is fed back to the acquisition team who will re-fly that particular part of the survey if necessary.

DATA PROCESSING QC PROCEDURES

The following steps are taken by the processing team to ensure a high quality standard of results.

- The processed data is examined (QC'd) for artifacts (i.e. spiking, surges or data inconsistencies), as well as areas of anomalous activity.
- If anomalous results/ artefacts are observed, this information is fed back to the processing team who will re-process that particular part of the survey if necessary.

To ensure the highest possible standard of results we are constantly looking into ways to improve its quality control procedures.

DATA QUALITY CONTROL AND DATA PROCESSING

Quality Control of the data will be performed by SMP GEOPHYSICS using an experienced field geophysicist at the base of operations.

The Quality Control will be undertaken by using a team concept. Instrumentation onboard the survey aircraft will permit basic quality control procedures. The team concept is continued at the Survey Base where a Geophysicist will undertake a more comprehensive QC analysis of the data, and will perform preliminary data processing. The data will then be given a second, and more complete review, wherein all the systems onboard the aircraft will be tested for compliance to the survey's specifications. Any problematic or unacceptable data will be identified and flagged for reflying by the survey crew. On a daily basis, this preliminary processed data will be sent to SMP GEOPHYSICS's data processing centre via broadband internet, where other Geophysicists will verify the QC.

Why Process the Data?

The survey data can undergo further processing. The purpose of processing the data will be to:

- Remove noise from the acquired data.
- Enhance the signal of the transient responses.
- Correlate anomalies across adjacent survey lines.
- Display the data so that anomalies across a broad area are identifiable.
- Make baseline adjustment.

Data Processing Procedure

The raw data collected in the field will be sent to the Data Processing. Below is a schematic diagram showing the acquisition and data processing workflow (Figure 9).

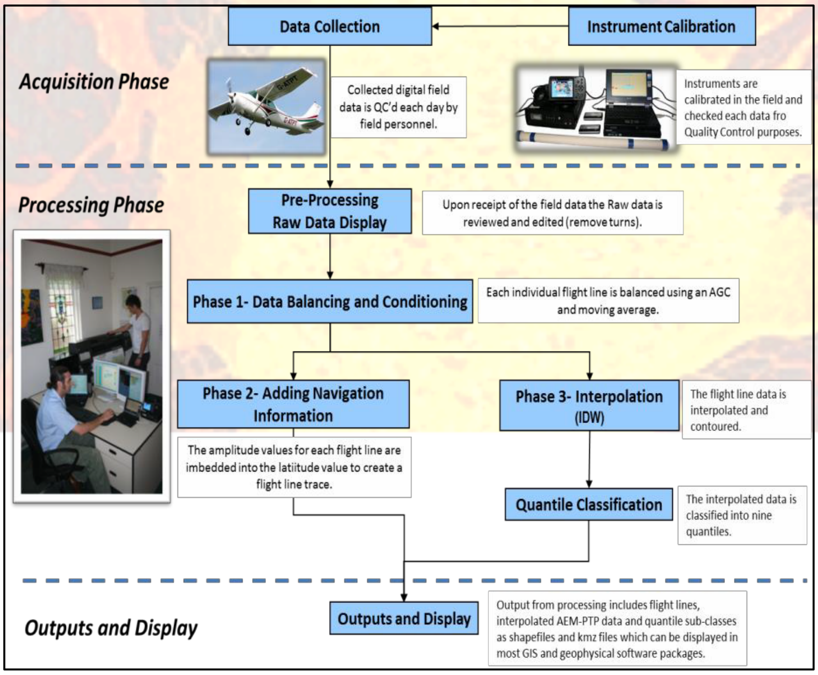


Figure 9 - Schematic diagram showing the processing workflow applied to AEM-PTP data

Processing Outputs

SMP GEOPHYSICS delivers a suite of processed data for analysis and interpretation including single flight line traces, interpolated AEM-PTP transient density attributes maps and quantile classified versions of the AEM-PTP transient density attribute maps.

1) Quantile Filtered Interpolated AEM-PTP Transient Density Maps

Portions of the transient density attribute maps may be excluded using the break values tool based upon their Quantile classification. The purpose of this exclusion is to highlight the most anomalous zones, Figure below shows the 5th quantiles display from the AEM-PTP transient density maps. This map shows one of the ten frequency bands collected. The main purpose of the maps is to draw attention to areas of high transient density (REDOX).

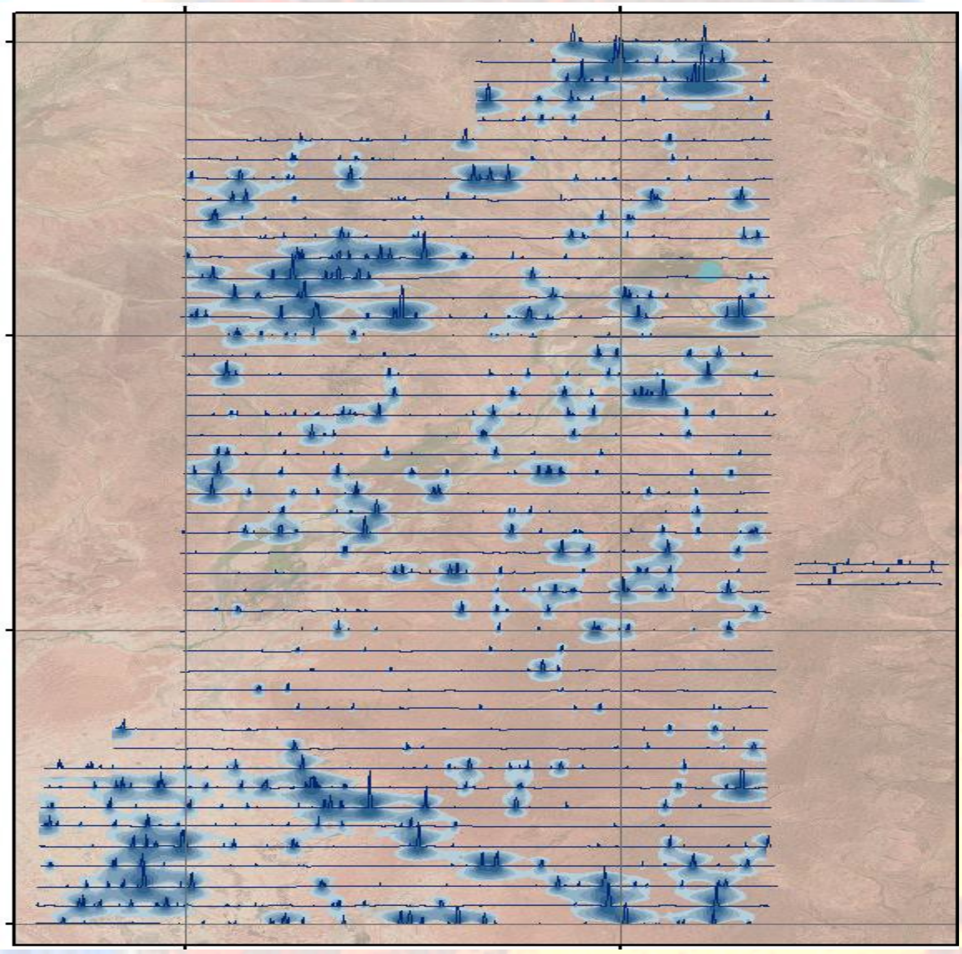


Figure 10 - Example of the 5th quantile display of the interpolated AEM-PTP transient density attribute maps from an Australian survey area.

It should be noted that the data will be interpolated to produce the final results.

INTERPRETATION

It is proposed that SMP GEOPHYSICS would undertake some of the interpretation process in collaboration with you.

Interpretation Workflows

The processed data would be interpreted at SMP GEOPHYSICS's Data Processing Centre by Pinemont's geophysicists. The schematic diagram below details the potential interpretation workflows that could be applied to the processed AEM-PTP data (Figure 11).

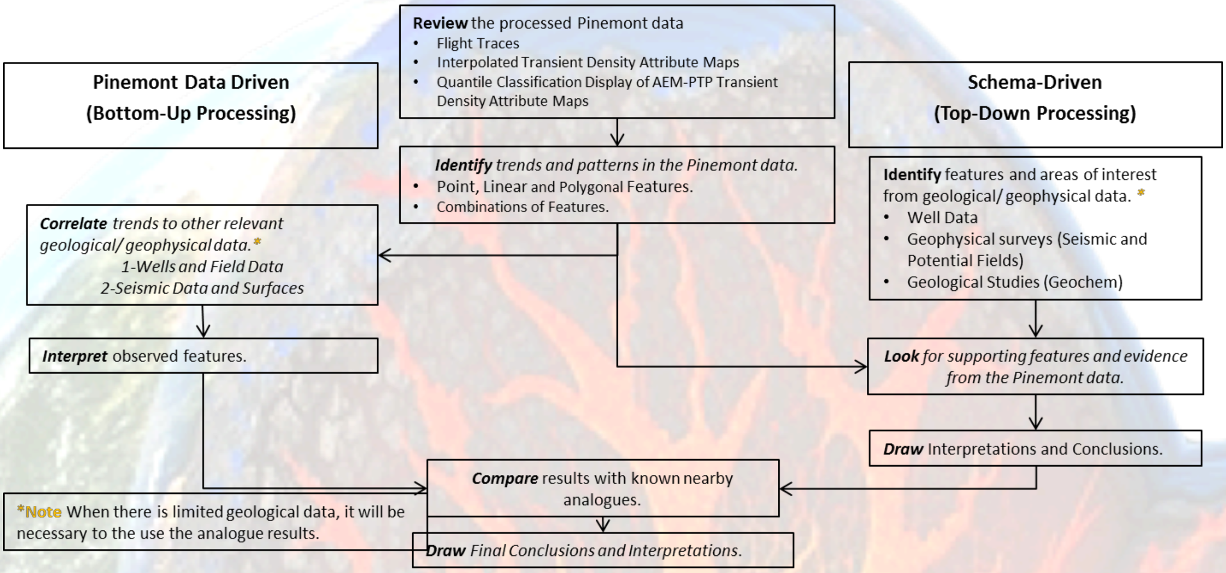


Figure 11 - Schematic diagram showing the interpretation process typically undertaken by Pinemont.

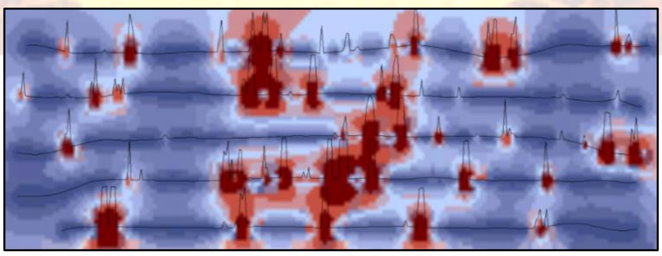
Interpretation Procedure

The proposed workflow that Pinemont would undertake to interpret the data is detailed in the following sections. In this example data from a mini-box of flights lines collected over a known Cooper Eromanga Basin Oil field. This is the type of data that would be collected initially in a new survey area.

Review and Identification of Anomalous Areas

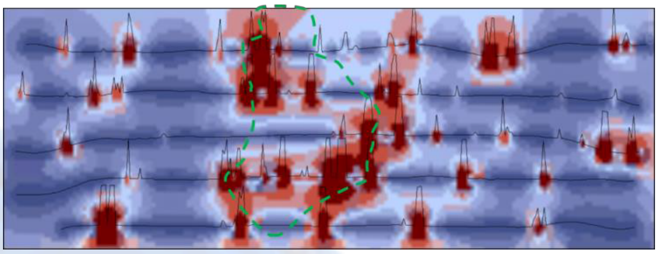
The first step that would be undertaken in the interpretation process would be to identify anomalies on the different frequency attribute maps (as shown in *Figure 12*) to see if any strong patterns emerge.

Figure 12 - Example of the identification of patterns and features on AEM-PTP data from the Cooper Eromanga Basin Oil field at a frequency range of 1200-1400 Hz.



When the oilfield outline is added to *Figure 12* on the map (green dashed line), the high transient density anomalies show a high degree of correlation with the edges of the field (*Figure 13*).

Figure 13 - The AEM-PTP transient density map with published field outline.



Generation of Anomaly Shapefiles

Shapefiles of the anomalies observed at the different frequency ranges will be generated during th interpretation procedure. These objects could then be brought into a GIS or seismic interpretation for comparison and integration with other geophysical data. This additional integration would be an additional service.

Comparison with Analogues

The results over the known fields will be compared and those results would be compared to the anomalies seen over the main survey areas.

Integration with Other Geophysical and Geological Data

The most important step in the interpretation workflow is the integration of AEM-PTP data with other geological or geophysical data collected. The data would be brought into either a GIS or seismic interpretation package as raster surface files or a set of anomaly shapefile objects and analyzed with other geological/ geophysical data.

DELIVERABLES

SMP Geophysicswill provide an in-house presentation of the results at a suitably arranged time. Pinemont staff will deliver the following deliverables:

Acquisition Deliverables

The following set of deliverables will be available during and at the end of the acquisition phase of a survey:

- KMZ files detailing the day by day progress of the flight survey.
- Raw Field data in ASCII file format.
- Acquisition Report

Post-Processing Deliverables

The following set of deliverables will be available during and at the end of the processing phase of a survey:

- KMZ files of the final processed results for each survey.
- Shapefiles of the final processed results for each survey.
- Processing Report.

Interpretation Deliverables

The following set of deliverables will be available during and at the end of the interpretation phase of a survey:

- Shapefiles of identified and interpreted anomalies at different frequency ranges.
- Interpretation Report.