SkyTEM survey, Dry Valleys, Antarctica, 2018

Data Delivery Note

1. INTRODUCTION

This document contains information about data collected during a 2018 EM airborne SKYTEM survey carried out under the USAP project *ANTarctic Airborne ElectroMagnetics (ANTAEM) - Revealing Subsurface Water In Coastal Antarctica*.

SkyTEM survey, Dry Valleys, Antarctica, field season 2018-2019	
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USAP Event No.	C-516-M, NSF/OPP Award 1644187
Locality	McMurdo Dry Valleys, Ross ice shelf, Antarctica
Survey period	November 2018
SkyTEM system	SkyTEM512
Lime km. acquired	~3400 km

2. DATA COLLECTION

2.1 The Survey

The SkyTEM survey was carried out in the period November 12th to 28th, 2018, with the SkyTEM 312 system. Twenty-one missions (flights) were conducted over 11 production days of helicopter service, resulting in a total of approximately ~3400 line km of data as shown in Figure 1. The SkyTEM system records data from take off until landing resulting in multiple lines converging to the landing pad at Marble Point. The production without overlapping lines adds up to approximately 2900 line km. The flight speed was approximately 120 km/h at a flight altitude of ~50 m (sensor height), where sensor height varies depending on the terrain. The surveys was carried out with a Bell 212 helicopter, which carried the SkyTEM sensor as a sling load.

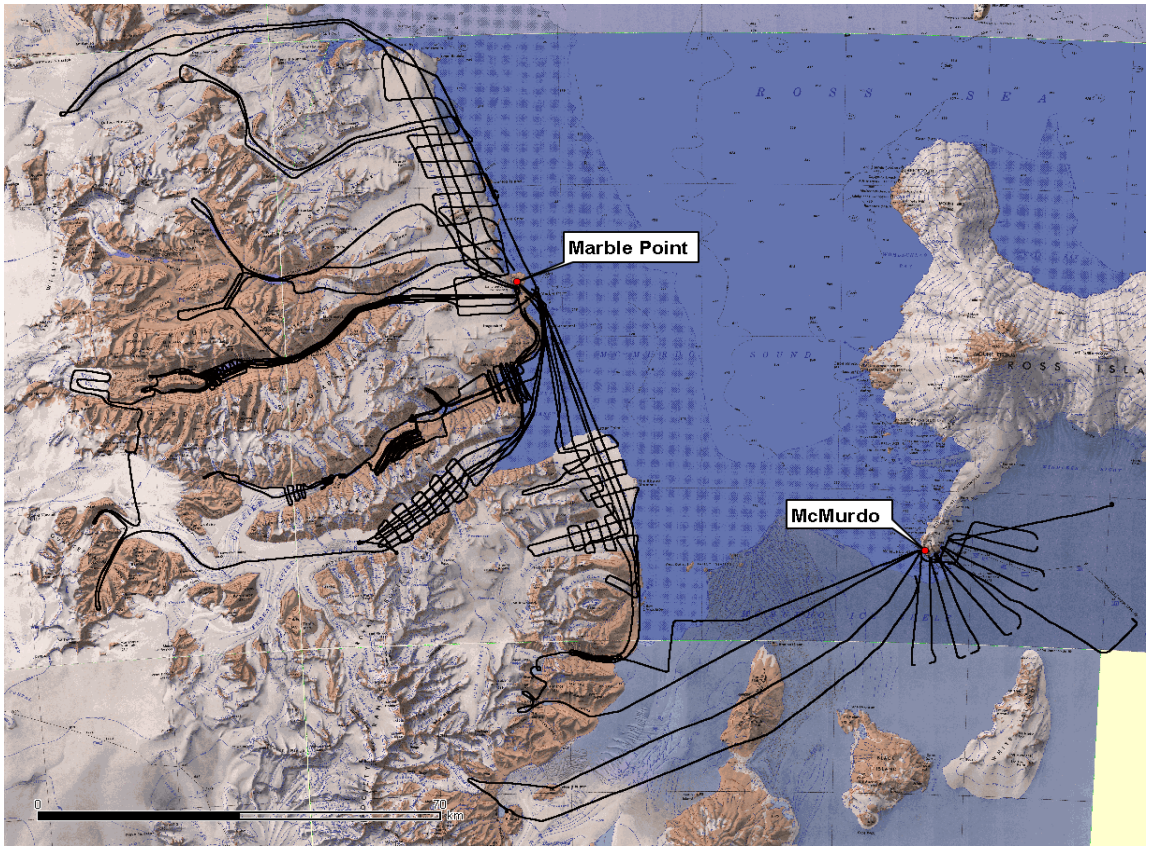

Figure 1. 2018 SkyTEM survey flight lines (black).

Targets

The 2018 targets including both infill and extension of the 2011 SkyTEM and 2017 ground based TEM surveys. This included surveys in new and unknown areas (in terms of electromagnetic exploration). The SkyTEM 312 system has a more powerful transmitter compared to the 2011 SkyTEM system, hence a lager depth of investigation. Therefore, some some of the 2011 targets were reflown to enhance penetration and confirm consistency with the previous survey. The locations of the 2017 ground based TEM soundings, the SkyTEM 2011, and the SkyTEM 2018 surveys are marked in Figure 2.

The 2018 targets on the Ross Ice Shelf were flown from a landing point outside McMurdo station, while Dry Valley targets were conducted from a basecamp/fueling station at Marble Point. One of the missions were carried out with re-fueling at the Mt. Round fuel cash, thus enabling targets further away from Marble Point to be mapped. The flight line layouts were planned and adjusted on a daily basis, partly based on on-site data processing.

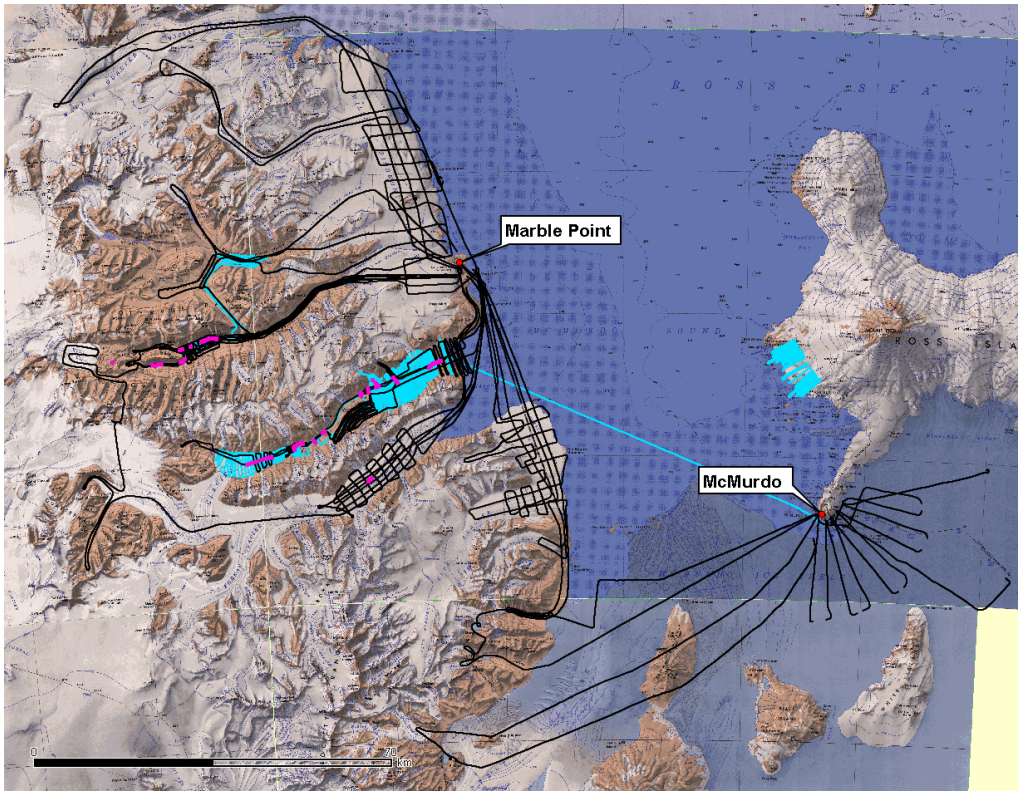

Figure 2. SkyTEM 2018 survey (black), SkyTEM 2011 survey (cyan), and 2017 ground based TEM soundings (magenta).

Signal level

Areas with extremely resistive dry and/or frozen sediment/bedrock, and glacier ice often produce EM-signals with amplitdues below the detection level of the system. Data from these low signal envrionments cannot be inverted into resistivity models. The black flight lines highlighted by red in Figure 3 marks areas where the signal level is high enough to produce data/resistivity models (can still result in a relative resistive model). Hence the black flight lines with no background color in Figure 3 marks areas with no detectible EM-signal, likely corresponding to a resistive ground with an absence of conductors to depths of 500-600m.

IP-signal

Strong Induced polarization (IP) effects, interfering with the TEM signal were observed for the data lines with a green background color in Figure 3. These data were discharged in this standard data delivery.

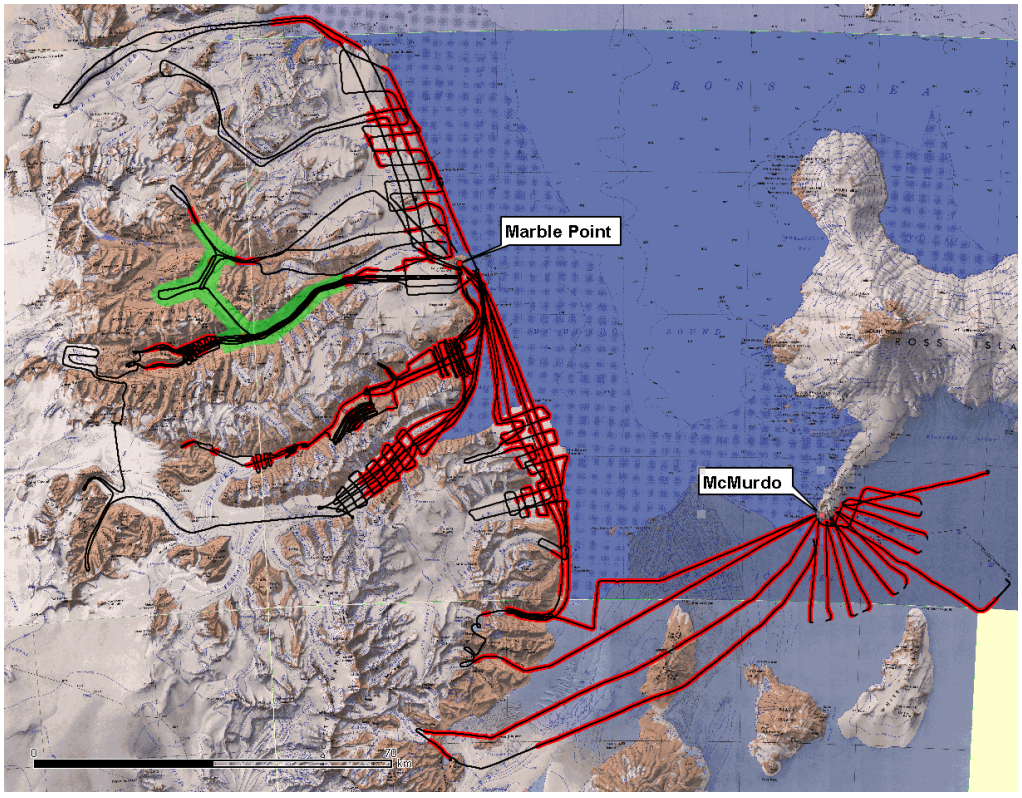

Figure 3. SkyTEM 2018 survey lines (black). Red background: EM-data inverted to a resistivity model. Green background: Data discarded due to strong IP-interference. No background color: Data discarded due non-detectible EM-signal.

2.2 SkyTEM - Technical Specifications

This section holds detailed technical specifications of the SkyTEM312 system setup for this survey.

The SkyTEM system was configured in a standard two-moment setup (low moment, LM and high moment, HM).

The system instrument setup is shown in Figure 4. The positioning of the instruments and the corners of the octagon described by the transmitter coil are listed in Table 1. The origin is defined as the center of the transmitter coil. The specification of the LM an HM moment are summarized in Table 2.

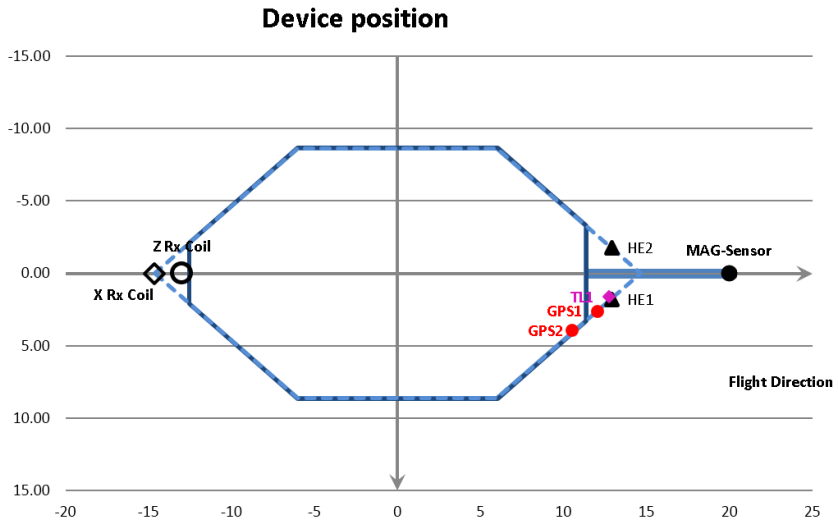

Figure 4. Instrument setup for the SkyTEM system used. HE 1 and 2 is laser altimeters, TL 1 inclinometer, GPS 1 and 2 are GPS sensors, X Z Rx Coil are the X and Z receiver coils.

Device Position

Unit	X (m)	Y (m)	Z(m)
DGPS1 (GPS)	11.68	2.79	-0.16
DGPS2 (GPS)	10.51	3.95	-0.16
HE1 (Altimeter)	12.94	1.79	-0.12
HE2 (Altimeter)	12.94	-1.79	-0.12
TL1 (inclinometer)	12.79	1.64	-0.12
TL2 (inclinometer)	12.79	1.64	-0.12
RxZ (Z-receiver coil)	-13.25	0.00	-2.0
RxX (X-receiver coil)	-14.65	0.00	0.00
Tx (center transmitter coil)	0.00	0.00	0.00
Mag sensor	20.50	0.00	-0.56
Loop corner 1	-12.64	-2.10	0.00
Loop corner 2	-6.14	-8.58	0.00
Loop corner 3	6.14	-8.58	0.00
Loop corner 4	11.41	-3.31	0.00
Loop corner 5	11.41	3.31	0.00
Loop corner 6	6.14	8.58	0.00
Loop corner 7	-6.14	8.58	0.00
Loop corner 8	-12.64	2.10	0.00

Table 1. Summary of equipment and transmitter coil corner positioning. The origin is defined as the center of the transmitter coil. Z is positive towards the ground.

Transmitter, Receiver Specifications

Parameter	LM	HM
No. of turns	2	12
Transmitter area	342 m^2	342 m^2
Tx Current	~ 6 A	~ 110 A
Tx Peak moment	~ 4,100 Am^2	~ 450,000 Am^2
Repetition frequency	210 Hz	30 Hz
Tx-on-time	0.8 ms	4.0 ms
Tx-off-time	1.581 ms	12.667 ms
Duty cycle	33%	24%
Gate time interval	0 µs – 1394 µs	0.376 ms – 10.731 ms

Table 2. Summary of low moment (LM) and high moment (HM) specifications.

3. XYZ-DATA FILE DELLEVIRY

The EM-data and inversion result (resistivity models) are delivered in the *SkyTEM2018_dat.xyz* and *SkyTEM2018_inv.xyz* files respectably. The RECORD number in the two files links data and model together. The content of the two xyz-files is specified in the following sections.

3.1 SkyTEM2018_dat.xyz file

EM-data and data uncertainty for data entering inversion.

Info stated in file Header:

- NAN value
- Data unit
- Coordinate system
- Gate times

The SkyTEM system uses at High-Low moment data recording cycle, therefore only a subset of the total 40 time gates are preset for each moment.

The content of the column data of the SkyTEM2018_dat.xyz file is stated in the table below.

SkyTEM2018_dat.xyz		
Colum	**Label**	**Description**
1	LINE_NO	Line number
2	UTMX	UTMX coordinate, WGS 84 UTM zone 58S (epsg:32758)
3	UTMY	UTMY coordinate, WGS 84 UTM zone 58S (epsg:32758)
4	RECORD	Global record number. Links the data to the resistivity model in in the SkyTEM2018_inv.xyz
5	ELEVATION	Surface elevation from composite DEM of SETSM and LiDAR data
6	ALT	High above the surface (m) for center of transmitter antenna.
7	NUMDATA	Number of data points (gates) in-use for the segment/sounding
8	SEGMENT	Transmitter moment indicator. 1=Low moment, 2=High moment
9-48	DATA_#	dB/dt data value (V/Am^4) for gate number #. NAN-values = data not in-use/not present
49-88	DATASTD_#	Data uncertainty for DATA_#, stated as a relative STD in log space. E.g. 0.03 → 1STD ~ [DATA#/1.03 ; DATA#*1.03]

3.2 SkyTEM2018_inv.xyz file

The standard lateral constraints inversion (LCI), delivered in the SkyTEM2018_inv.xyz file, was carried out with a smooth 30 layered resistivity model discretized to a depth of 500 m. A depth of investigation (DOI) were estimated for each resistivity model.

The content of the columns of the SkyTEM2018_inv.xyz file is stated in the table below.

SkyTEM2018_INV.xyz		
Colum	**Label**	**Description**
1	LINE_NO	Line number
2	UTMX	UTMX coordinate, WGS 84 UTM zone 58S (epsg:32758)
3	UTMY	UTMY coordinate, WGS 84 UTM zone 58S (epsg:32758)
4	RECORD	Global record number. Links the model to the EM-data in the SkyTEM2018_inv.xyz
5	ELEVATION	Surface elevation from composite DEM of SETSM and LiDAR data
6	ALT	High above the surface (m) for center of antenna.
7-36	RHO_I_#	Resistivity (ohm*m) of layer#.
37-65	THK_#	Thickness of layer #.
66	DOI_STANDARD	Estimated depth of investigation (m).