# University of Manitoba
# 2015 Geophysics Field School

## Birds Hill Project: Data Analysis
## GPR and TEM surveys

**Groups:**

- Questions 1-3 should be completed by the data acquisition group
- Questions 3-6 should be completed with your partner(s)
- Questions 7-9 should be completed individually.

All work is due at 10 PM.

- The data archiving must be submitted *electronically* on a jump drive to an instructor, in a folder with project name and group number in the name, and subfolders indicating the particular survey.
- Data reduction and analysis answers should be submitted in hard-copy with one copy submitted for each data analysis pair or trio. The results can be submitted in hand-written form.
- The interpretation answers should be submitted in hard-copy with one copy submitted for each person. The results can be submitted in hand-written form.

**Data Archiving:**

**1.** Using the program PTTRAN, an instructor will extract the noise and TEM sounding data from the PROTEM47 data file. The TEM data will be provided to you as both decays in mV and as late-time apparent conductivity values. The late-time apparent conductivity is valid for times at which the skin depth greatly exceeds the transmitter-receiver separation. The time-domain skin depth is defined:

$$\delta_{TD} = \sqrt{\frac{2t}{\sigma \mu_0}} \qquad \text{Eq. 1}$$

where $\mu_o = 4\pi \times 10^{-7}$ H.m$^{-1}$.

**2.** The data should be carefully archived with a README file explaining its format, date and place of collection, the group who collected it, the group who archived it, and any other pertinent details (*i.e.* survey configuration). It is necessary to submit only one set of results per field group. Hand in the data and README files electronically.

**3.** You will be provided with hard copies of the GPR results. A README file should be created for the GPR acquisition and submitted electronically.

**Data Reduction and Analysis:**

**4.** Comment on the signal and noise levels in the decay curve results. Can the early time signal be seen at any of the offsets? What is the latest time that useful signal can be observed?

**5.** Using the apparent conductivity results, estimate the skin-depth at Gates 5 and 15 in the TEM central loop sounding. Comment on the overall penetration of the TEM results compared with the other methods employed at the site.

**6.** The GPR velocity is defined by:

$$v = \frac{c}{\sqrt{k}} \qquad \text{Eq. 2}$$

where $k$ is the dielectric constant or relative electrical permittivity ($\varepsilon/\varepsilon_0$, also denoted $\varepsilon_r$) and $c$=3.0x10$^8$ m.s$^{-1}$=0.3 m.ns$^{-1}$. Using the values of dielectric constants or velocities in Table 1, estimate the range of depths over which the 200 MHz and 400 Mz GPR antennas provided useful results.

**Interpretation:**

**7.** Describe the apparent conductivity plots and provide a geological interpretation of the observed TEM apparent conductivity results.

**8.** Provide a geological interpretation of the GPR results.

**Table 1. Dielectric constant and radar velocity in Earth materials (Reynolds, 1997).**

| Material | $\varepsilon_r$ | $V$(mm/ns) |
|---|---|---|
| Air | 1 | 300 |
| Water (fresh) | 81 | 33 |
| Water (sea) | 81 | 33 |
| Polar snow | 1.4–3 | 194–252 |
| Polar ice | 3–3.15 | 168 |
| Temperate ice | 3.2 | 167 |
| Pure ice | 3.2 | 167 |
| Freshwater lake ice | 4 | 150 |
| Sea ice | 2.5–8 | 78–157 |
| Permafrost | 1–8 | 106–300 |
| Coastal sand (dry) | 10 | 95 |
| Sand (dry) | 3–6 | 120–170 |
| Sand (wet) | 25–30 | 55–60 |
| Silt (wet) | 10 | 95 |
| Clay (wet) | 8–15 | 86–110 |
| Clay soil (dry) | 3 | 173 |
| Marsh | 12 | 86 |
| Agricultural land | 15 | 77 |
| Pastoral land | 13 | 83 |
| Average 'soil' | 16 | 75 |
| Granite | 5–8 | 106–120 |
| Limestone | 7–9 | 100–113 |
| Dolomite | 6.8–8 | 106–115 |
| Basalt (wet) | 8 | 106 |
| Shale (wet) | 7 | 113 |
| Sandstone (wet) | 6 | 112 |
| Coal | 4–5 | 134–150 |
| Quartz | 4.3 | 145 |
| Concrete | 6–30 | 55–112 |
| Asphalt | 3–5 | 134–173 |
| PVC, Epoxy, Polyesters | 3 | 173 |

## REFERENCES

Reynolds, J.M. 1997. *An Introduction to Applied and Environmental Geophysics,* Wiley, New York, 896 pp.