Applying a diurnal correction to magnetic data

Two sets of examples are referenced below. The files are found in the folders /Example1 and /Example2

Example 1: Diurnal correction of ground mag data with 1 base station.

Example 2: Processing of data from 2 base stations into a single diurnal correction channel.

1) Import base station data into QCTool using the appropriate import for the raw data file.

Example 1: mar20_base_orig.qct.

Contains 2 channels: a) **time** and b) **base** (magnetic field measured at base station)

→ If you had multiple base stations measuring at the same time, or have access to data at a magnetic observatory in addition to the base station, then import these files separately, and merge as follows:

- Select **Merge Files** under Tools -> Files.
- Select **Union of Files** as the merging mode.
- Select one base station file as the first file, and the other as the second file.
- Choose time as the base channel.
- Click **Merge**.

You will now have a file with two base station mag channels. Rename if needed.

Example 2: merge_baseAB.qct, created by merging **baseA.qct** and **baseB.qct**.

2) Process base station data

a) *For 1 base station:*

Example 1: mar20_base_processed.qct.

- Plot the base station data.
- Remove any data outside the time during which the survey data was collected. Right click on the time channel, select **Processing**, then **Outlier Removal**. Use this tool to remove data outside a specific time window.
- Remove any bad data manually, such as spikes caused by instrument malfunction, by clicking the **Delete Points** button. Should you have many spikes from drop-outs, for example, you might use the **Outlier Removal** tool to do this automatically. See channel: **base_spikeremoval**.
- Following careful examination of the data, you may wish to filter the data to remove instrument noise. **Digital filters** are located under **Processing**. Two filters were applied in the example. See channels: **base_spikeremoval_Median9** and **base_spikeremoval_Median9_Mean35**.

- Subtract an appropriate constant (such as the average background field) from the base station data to obtain the diurnal correction. You may wish to create a new data channel for this step. See channel: **diurnal_correction**.
- If desired, save a new file (**Save As**) with only the time and final diurnal correction channel to simplify merging with the survey data. See: **mar20_diurnal_corr.qct**

b) *For 2 base stations:*

Although ultimately you want a single diurnal correction channel, having multiple base stations allows more accurate processing.

Example 2: merge_baseAB.qct

i) Remove bad data

- Plot both base station data channels. (Channels in example: **A_base_mag** and **B_base_mag**.)
- Remove any data outside the time during which the survey data was collected. Right click on the time channel, select **Processing**, then **Outlier Removal**. Use this tool to remove data outside a specific time window.
- Carefully examine the plot and remove non-coherent events. This is an advantage of having multiple base stations. In the example, there is excellent agreement between the two bases.

Note: In this example there is a DC shift in response between the two magnetometers of about 30 nT. Base A data has been shifted to the level of the Base B data (see channel: shift_A) before proceeding with the next step.

ii) Average and Filter

Note: If one base station has much better quality data than the other, you may wish to use only that one for the diurnal correction. If this is the case, do not average.

- **Interpolate** both data channels with respect to time. (Right click on data channel, select **Processing** then **Interpolate Channels**.)
- Select the channel beside which you would like to create a new channel for the averaged base station data. Right click, and select **Insert Channel**.
- Enter the name of the new channel, and select the format and whether the channel will be placed before or after the current channel. Click **Insert.** (Channel: **mean_base**)
- In the spreadsheet toolbar, click **Transform Data** (the calculator).
- Enter the formula to average the two base station channels, and select the rows to which you wish to apply the formula. Click **Apply**.
- If desired, filter to reduce instrument noise and other small amplitude non-coherent signals. **Digital filters** are located under **Processing**. Filtered data will be in a new channel; compare with the original averaged data until you are happy with the result of the filtering. (Channel: **mean_base_filter**.)

iii) Create diurnal correction channel

- Insert a new channel as described above. Subtract an appropriate constant (such as the average background field) from the averaged base station data to obtain the diurnal correction. (Channel: **diurnal_correction.**)

- You may wish to save a new file (**Save As**) with only the time and final diurnal correction channel for ease of merging with the survey data.

3) Merge survey data and diurnal correction

Example 1: mar20_merge.qct, created by merging:

a) **mar20_surveyline.qct** (survey data) with b) **mar20_diurnal_corr.qct** (diurnal correction)

- Select **Merge Files** under Tools -> Files.
- Select **Union of Files** as the merging mode.
- Select your survey data as the first file, and the file containing the final diurnal correction (from Step 2) as the second file.
- Choose time as the base channel.
- If your survey data is split into multiple lines, go to **Set Merge Pairs of Lines**. However, we recommend keeping the survey data in a single line in the QCTool file until after the diurnal correction. Uncheck "interpolate"—we recommend that you do this later as needed.
- Click **Merge**.

4) Apply correction

Example 1: mar20_merge.qct

- Select the diurnal correction channel, right click, select **Processing**, then **Interpolate channels**.
- Select time as the base channel, then click **Interpolate**.
- Select the channel beside which you would like to create a new channel for the diurnally-corrected magnetic data. Right click, and select **Insert Channel**.
- Enter the name of the new channel, and select the format and whether the channel will be placed before or after the current channel. Click **Insert.** (In the example, this is channel **mag_corr**.)
- In the spreadsheet toolbar, click **Transform Data** (the calculator).
- Enter the formula to subtract the diurnal correction channel from the magnetic data channel, and select the rows to which you wish to apply the formula. Click **Apply**.
- Remove data points at which there is no survey data (i.e., only base station data.) Select the channel with the corrected magnetic data, go to **Outlier Removal**, and remove points with dummy values. In the example, the result has been saved in a new file: **mar20_corrected.qct**