

Invert Model with GM-SYS Profile Modelling

Forward modelling involves creating a hypothetical geologic model and calculating the geophysical response to that earth model. GM-SYS Profile, without Inversion/ Optimization, is a forward modelling program allowing interactive manipulation of the earth model and real-time calculation of the gravity or magnetic response.

Inversion, optimization, or inverse modelling involves the reverse procedure. Starting with the observed geophysical response, an earth model that will provide the best fit to that data is calculated.

 *If GM-SYS Profile is licensed at the Basic level, both the Invert option in the Action menu and the **Invert** button on the Action toolbar are "grayed-out" and inactive.*

Inverting a Model

The inversion process begins with activation of the Inversion Setup dialog by selecting the **Invert** option from the *Action* menu or Action toolbar. The dialog controls the inversion process. Inversion is accomplished in two steps:

1. Inversion Setup
2. Run Inversion Calculations

Setting up an Inversion

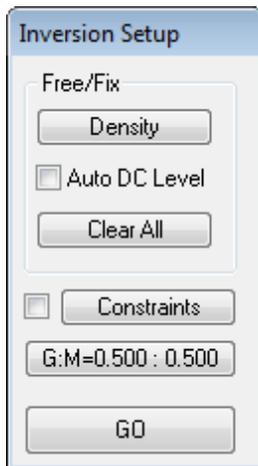
Up to 20 parameters may be freed for inversion: parameters include the X-coordinate of a point, the Z-coordinate of a point, the density of a block, the susceptibility of a block, and the DC level. Each selection acts to toggle the parameter between free and fixed.

Freeing the positions of multiple points and the properties of several blocks may produce geologically unreasonable solutions, even though the fit of the model response to the data is good. In general, it is better to free only a few parameters at one time.

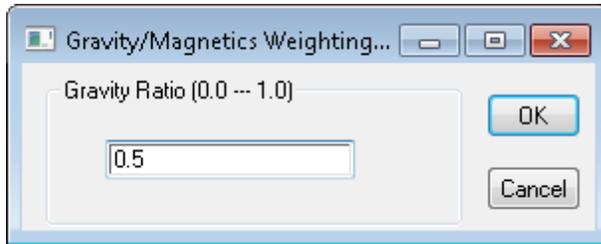
GM-SYS Profile leaves the interpretation of geologic "reasonableness" to you, the interpreter.

To Set Up an Inversion

1. On the *Action* menu, select **Invert**. The *Inversion Setup* dialog opens.



2. Click the **X** drop-down list to select the parameter to free. XZ frees 2 parameters!
3. **Click** on the model point you wish to free. The point is replaced by a bar or bars oriented in the direction of freedom.
4. In order to free block parameters, select **Density** or **Susceptibility** from the drop-down list.
5. **Click** on the block you wish to free. A <D> or <S> symbol will appear near the block label to indicate that the density or susceptibility, respectively, has been freed for that block.
6. Check **Auto DC Level** to allow the DC level, or DC offset, to vary within the optimization process.
 Allowing the DC level to be free may allow the optimization to fit the shape of an anomaly without matching the DC level. The "reference station" does not change in the optimization process, so the final " solution" may appear to be shifted from the observed data.
 Generally, when modelling a realistic geologic section, the DC level should remain fixed. Make sure the reference station is not in the part of the profile which you are trying to optimize. As a general rule, the fixed point should be near one end of the profile, in a section where you are not changing the geologic model.
7. The **Clear All** button fixes all model parameters, but does not reset the Gravity:Magnetics weighting (see below).
8. Check **Constraints** to limit the distance that freed points may move during each inversion iteration. The Constraints dialog box appears.
9. Enter a maximum Range *distance* for dX or dZ. The units for each direction may be changed independently, but default to the horizontal and vertical units of the Cross-Section pane.
10. Click **OK**.
11. The **Constraints checkbox** (to the left of the constraints button) must be checked in order for these constraints to take effect.
12. Click the **G:M** button to change the gravity-- magnetics weighting.



The inversion defaults to give equal weight to the gravity and magnetics calculations (Gravity:Magnetics = 0.5:0.5). A value greater than 0.5 favors the gravity calculations; less than 0.5 favors magnetics. To optimize for only gravity or magnetics, use 1.0 and 0.0, respectively.

Performing an Inversion

After preparing the model for inversion, the actual inversion process is initiated using the **GO** button. Other GM-SYS Profile functions are disabled during the inversion/optimization process.

Inversion is a non-linear process with non-unique solutions in most cases. Inverting on the susceptibility or density of a single block should result in convergence after a single iteration.

To Perform an Inversion

1. On the *Action* menu, click **Invert**.
2. Confirm that the Inversion Parameters are correctly defined.
3. Click **GO**. The *Iterations* dialog appears.



The calculated response curves are updated in the Anomaly Panes, leaving a dotted line as the previous calculated curve. Fields at the bottom of the Iterations dialog box report the change in the RMS error for the gravity and magnetic response. The reported errors are calculated only for an "active area" of the profile which may be affected by changes being made to the model.

4. Click **Next Step** to perform another inversion iteration.

5. Click **Accept** when you are ready to accept the changes and close the *Iterations* dialog. The changes appear in the model.



Undo returns the model to its state prior to the last step of the iteration while **Cancel** rejects all changes.

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