GEOSOFT

Oasis montaj Best Practice Guide

VOXI Earth Modelling - Sharpening using Iterative Reweighting Inversion

The software described in this manual is furnished under license and may only be used or copied in accordance with the terms of the license.

Manual release date: February-27-13.

Please send comments or questions to info@geosoft.com

© 2012 Geosoft Inc. All rights reserved. Geosoft is a registered trademark and Oasis montaj is a registered trademark of Geosoft Inc. Other brand and product names mentioned herein are properties of their respective trademark owners. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form, or by any means, electronic, mechanical, photocopying, reading, or otherwise, without prior consent from Geosoft Inc.

The software described in this manual is furnished under license and may only be used or copied in accordance with the terms of the license. OM.h.2012.04

Windows™, and Windows NT are either registered trademarks or trademarks of Microsoft Corporation.

Geosoft Incorporated
Queen's Quay Terminal
207 Queen's Quay West
Suite 810, PO Box 131
Toronto, Ontario
M5J 1A7
Canada
Tel: (416) 369-0111
Fax: (416) 369-9599

Website: www.geosoft.com
E-mail: info@geosoft.com

Support

For obtaining technical support, email support@geosoft.com

If you wish to speak to a technical support representative in your region, please visit the Geosoft Support page at: www.geosoft.com/about-geosoft/contact-us/world-offices for contact information.

Sharpening using Iterative Reweighting Inversion

Introduction

Voxel inversion of geophysical data is ill-posed, or in layman's terms, there are many earth models which satisfactorily fit the observed geophysical data. Therefore, in order to produce an earth model from the data, the geoscientist must supply auxiliary information. In the absence of auxiliary geological information, the principle of Occam's razor is frequently assumed, i.e. the inversion result should have no more structure than is absolutely necessary to reproduce the data. If structure is measured by computing the gradient of the model, then a 'smooth' model will be recovered by the inversion. This is a robust and mathematically viable approach; however, these smooth models do not, in fact, adequately represent the true geology. The geology is inherently complex, comprised of distinct rock units with relatively clear boundaries; the geophysical properties on either sides of the contact generally exhibit discontinuity, and as a result, the transition is more often quite sharp. In VOXI, we are able to sharpen up smooth models and produce a more geologically reasonable inversion result using Iterative Reweighting Inversion (IRI) .

Producing a Smooth Model

We begin by considering a simple dipping sheet in a half space model as shown in *Fig. 1*. For simplicity, in all that follows, we will view only the section through the center of the model. We simulate the TMI response over the sheet and then invert the response with VOXI, using all defaults, to yield the result shown in *Fig. 2*. We will call this the "default" VOXI result and we can see that it is a reasonable approximation to the true model.

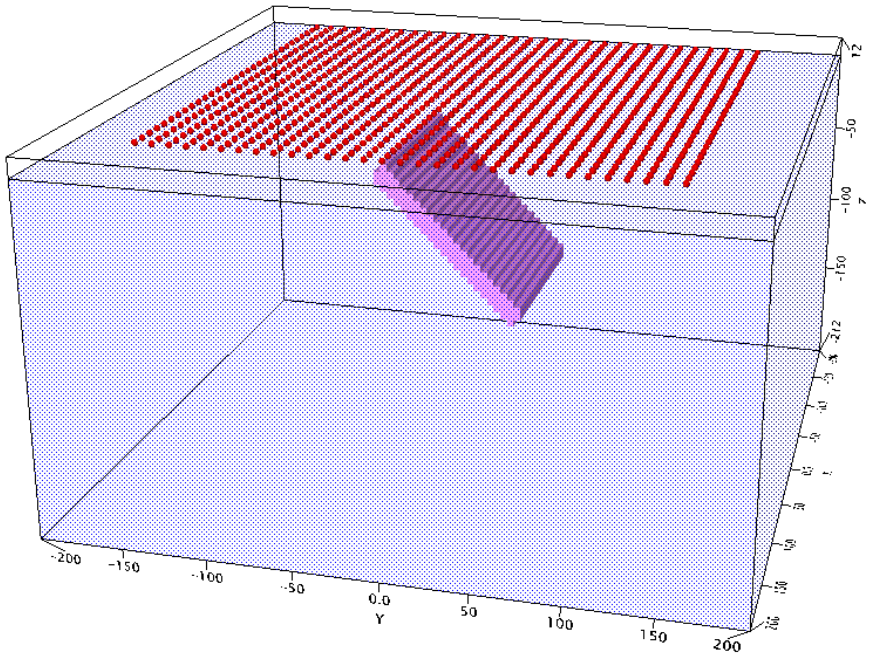

Fig. 1: The Dipping Sheet Model

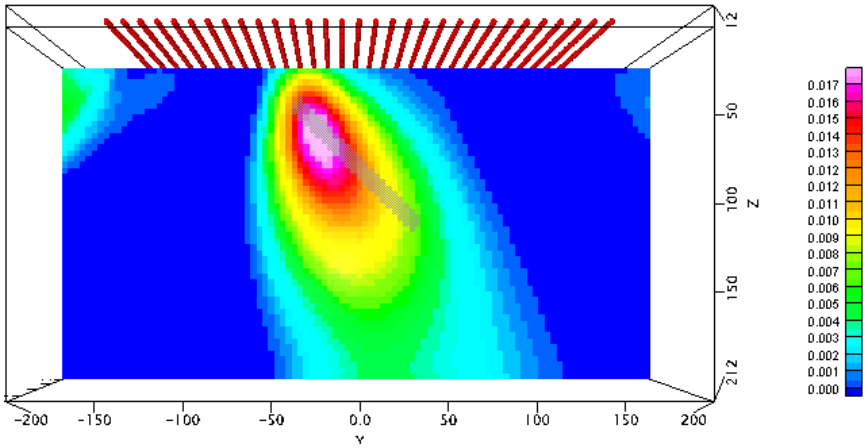

Fig. 2: The "default" VOXI inversion model for the Dipping Sheet Model. The true model is shown overlaid in grey.

Producing a Sharper Model

The default inversion result shown in *Fig. 2* displays many good features of the true model and validates the default VOXI inversion process. The recovered model correctly shows a dipping target localized on the true dipping sheet. The recovered model can be sharpened in VOXI by taking the default inversion result and entering it as an Iterative Reweighting constraint and rerunning the inversion. This process can be applied automatically by selecting the IRI focus option of the Reweighting constraint. To further sharpen the model, increase the number of iterations. Obviously, this is an iterative process, and explains the motivation for the name: *Iterative Reweighting constraint* and it is good practice to run two iterations for optimal results.

The results of two sharpening iterations are shown in *Fig. 3*, all on the same colour stretch. The upper panel shows the 0^{th} iteration (the default model), the middle panel shows the first IRI iteration, and the lower panel shows the second IRI iteration. The recovered model has been significantly sharpened with IRI and approximates the true dip of the target more accurately. A natural consequence of the sharpening is to increase the amplitude of the recovered susceptibility by approximately a factor of two between iterations. This brings the recovered physical properties closer to geologically reasonable values.

Conclusion

Iterative reweighting inversion (IRI) in VOXI is a powerful technique that can be used to sharpen smooth inversion results. IRI not only sharpens the inversion result, but it also improves the geometry of the result and the amplitudes of the recovered physical properties. Although we have demonstrated its utility only on susceptibility inversion of TMI data, the process is entirely general and applies to all types of inversion, even Magnetization Vector Inversion (MVI), in which case the amplitude of the recovered magnetization is usually used as the IRI input. Experience has shown that two IRI iterations provides a significant improvement over the default inversion, and is recommended in most cases.

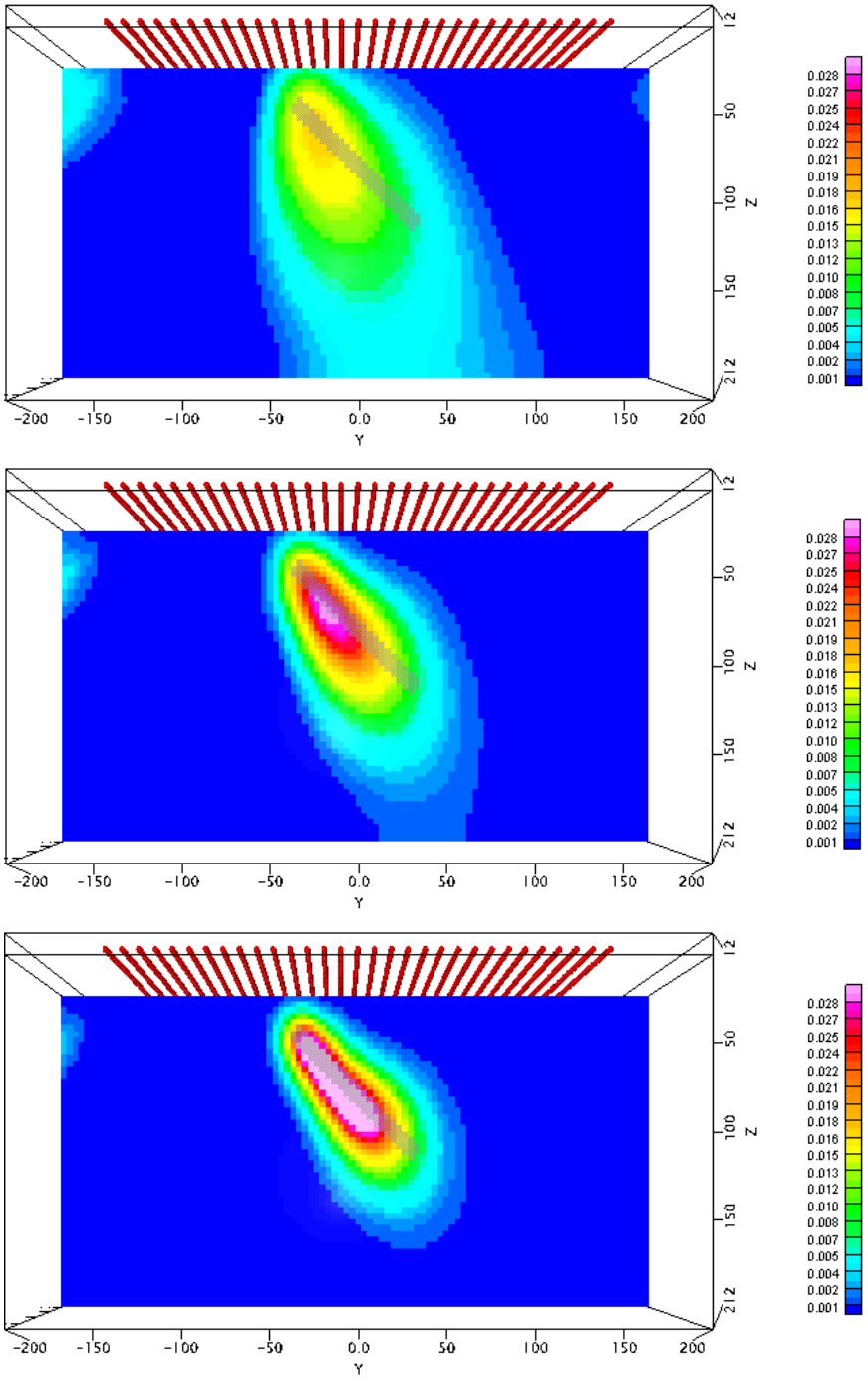

Fig. 3: A section view through the recovered models from 0, 1, and 2 IRI iterations. The true dipping sheet is shown overlaid in grey.