Preliminary Study on Multi-dimensional and Multi-scale Gravity and Magnetic Data Fusion Scheme

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Abstract

Gravity and magnetic prospecting is widely used in solving geology problems because of their advantages, such as efficient and economy, green and environment-friendly, widely coverage and strong horizontal resolution. In order to well study in the geology problems, comprehensive use of the different scales (different scales data) and different dimensions (satellite data, aeronautical data, ground data, ocean data, well data, etc.) gravity and magnetic data which were observed in different periods. However, the study of the multi-dimensional and multi-scale gravity and magnetic data comprehensive use is still stay in the exploration stage. In this paper, we did research on the key technique of fusion with the potential field data (gravity and magnetic data): how to fuse the different scales and different dimensions field data into a unified reference and a same location. Based on this research we propose a fusion scheme of multi-dimensional and multi-scale gravity and magnetic data.

Method

In order to realize the fusion of the multi-dimensional and multi-scale gravity or magnetic anomaly data, we need to solve the three problems, the unify of the different dimensions, the different scales and the background field. We formulated the technical workflow of the fusion scheme (Figure 1) that we proposed.

![Technical workflow of the fusion scheme](image)

Model Tests

The theoretical model is a model that combines 5 vertical hexahedrons (Figure 2). There are 3 observation surfaces, and the scale of observation surface 1 and 2 are the same and is two times of observation surface 3. These 3 observation surfaces have white and superimposed region on the horizontal direction and are different dimensional (Figure 3). Their forward data of gravity and magnetic anomalies are shown in Figure 4 and Figure 5. Through the fusion workflow that we proposed we get the fusion potential field data on the plane surface of z=0km, -2km, -4km and -6km (Figure 6 and Figure 7), and the error was calculated.

![Schematic diagram of model location](image)

![Multi-dimensional observation surface](image)

![Gravity anomalies on the observation surface](image)

![Magnetic anomalies on the observation surface](image)

![Fusion gravity anomalies](image)

![Fusion magnetic anomalies](image)

<table>
<thead>
<tr>
<th>Error</th>
<th>Gravity Anomalies (mGal)</th>
<th>Magnetic Anomalies (nT)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0km</td>
<td>2km</td>
</tr>
<tr>
<td>Average error</td>
<td>0.006</td>
<td>0.001</td>
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<tr>
<td>RMS Error</td>
<td>0.064</td>
<td>0.012</td>
</tr>
<tr>
<td>Relatively RMS Error (%)</td>
<td>0.847</td>
<td>0.428</td>
</tr>
</tbody>
</table>

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Real Data

(1) Real gravity anomaly data

Figure 8 Aeronautical gravity anomaly(Scale:1:50,000)
Figure 9 Ground gravity anomaly(Scale:1:50,000)
Figure 10 Ground gravity anomaly(Scale:1:200,000)

Figure 11 Observation surface of the aeronautical gravity
Figure 12 Observation surface of the ground gravity

(2) Single-dimensional and multi-scale fusion test

Figure 13 Fusion gravity using the two ground gravity data whose scale are 1:50,000 and 1:200,000

(3) Multi-dimensional and single-scale fusion test

Figure 14 Fusion gravity using the aeronautical gravity data and the ground gravity data whose scale are all 1:50,000

(4) Multi-dimensional and multi-scale fusion test

Figure 15 Fusion gravity using the two ground gravity data whose scale are 1:50,000 and 1:200,000 and the aeronautical gravity data whose scale is 1:50,000

The test of single-dimensional and multi-scale fusion are used the two ground gravity data whose scale are 1:50,000 and 1:200,000 (Figure 13). The test of multi-dimensional and single-scale fusion are used the aeronautical gravity data and the ground gravity data whose scale are all 1:50,000 (Figure 14). The test of multi-dimensional and multi-scale fusion are used the two ground gravity data whose scale are 1:50,000 and 1:200,000 and the aeronautical gravity data whose scale is 1:50,000 (Figure 15). The deviation of the observation ground gravity data and the calculated gravity data on the ground from the aeronautical gravity data are statistics.

Conclusion

The fusion workflow we proposed in this presentation can be used in the fusion of the multi-dimensional (aeronautical, ground and ocean) and multi-scale gravity and magnetic data. The tests on theoretical models show that this fusion workflow is able to achieve the fusion of the multi-dimensional and multi-scale gravity and magnetic data. It has well fusion results and small error, the fusion data conform to the characteristics of the potential field data and can meet the needs of later processing and transformation for data. The fusion workflow is used to achieve the fusion of measured aeronautical gravity data and ground gravity data at different scales in a certain place of China. The fusion workflow we proposed has good practical significance and promotion value.

References


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