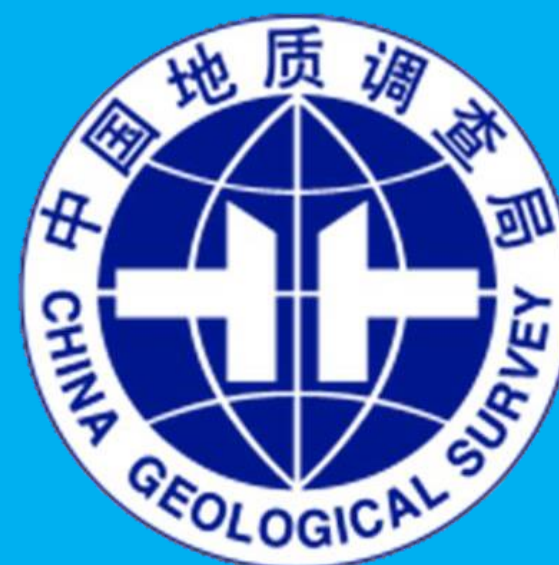# Preliminary Study on Multi-dimensional and Multi-scale Gravity and Magnetic Data Fusion Scheme

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Abstract

Gravity and magnetic prospecting is widely used in solving geology problems because of theirs 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.
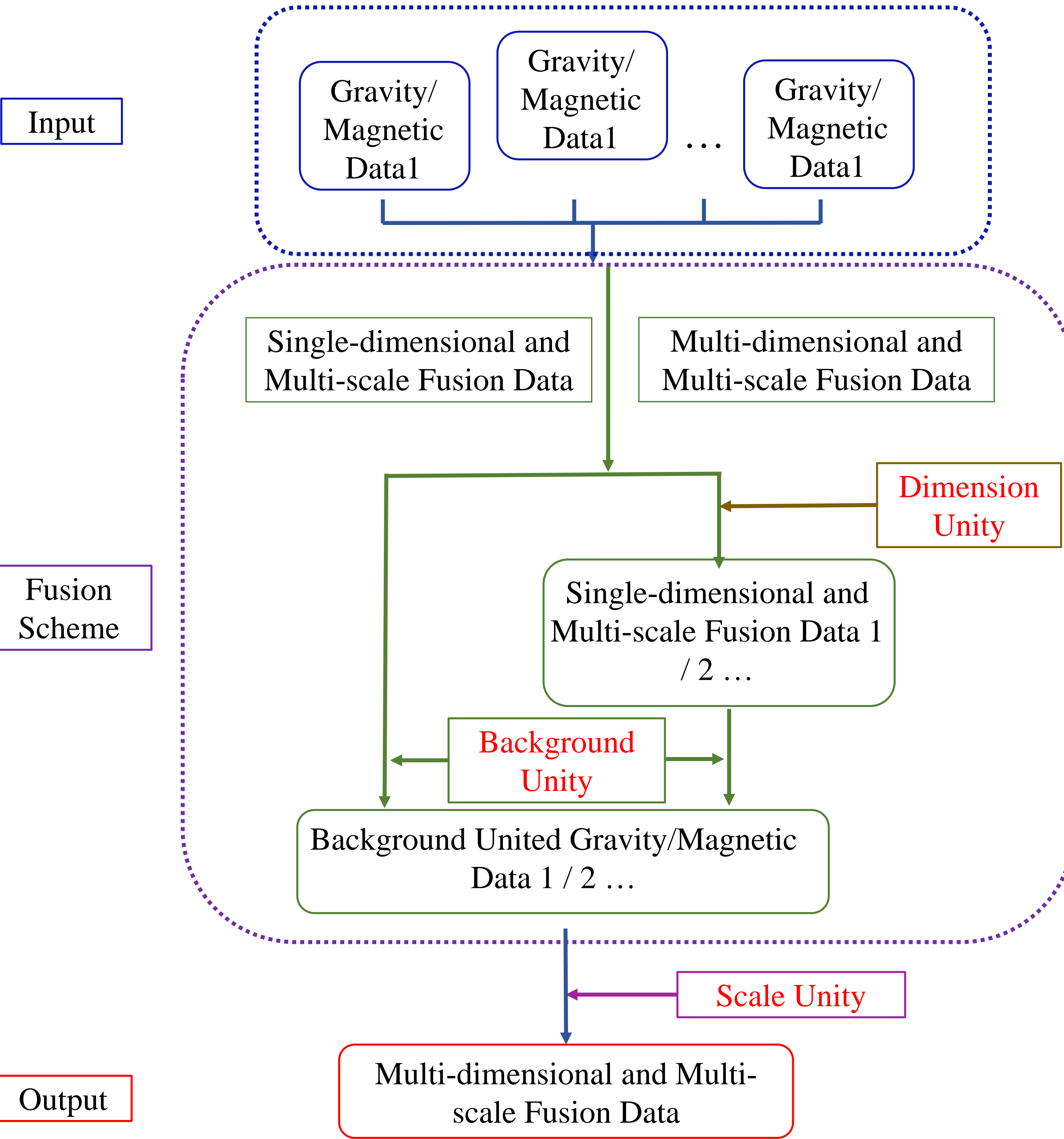

Figure 1. Technical workflow of the fusion scheme

Model Tests

The theoretical model is a model that combinates 5 vertical hexahedrons (Figure 2). There are 3 observation surface, and the scale of observation surface 1 and 2 are the same and is two times of observation surface3. 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.
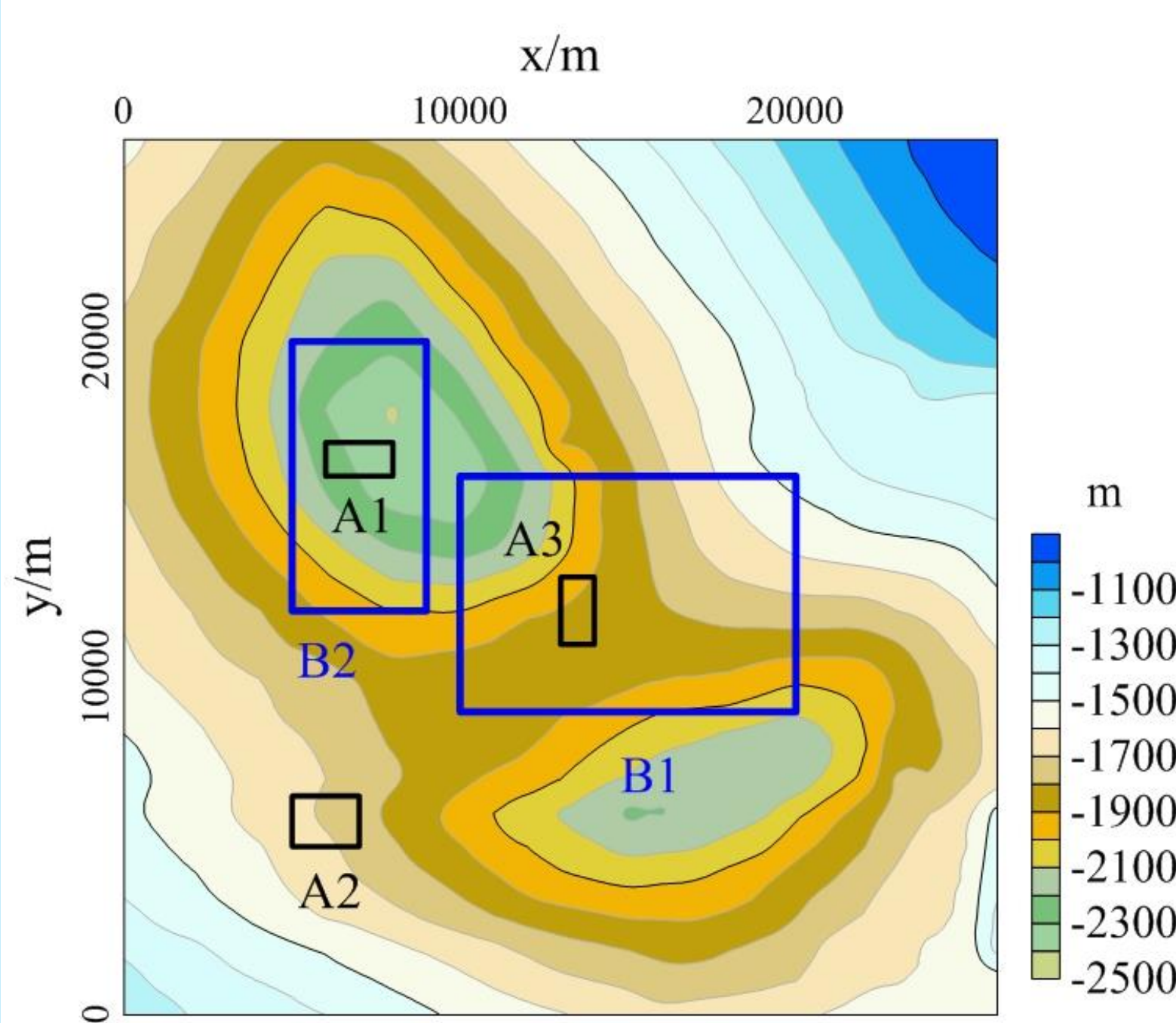
Model Tests

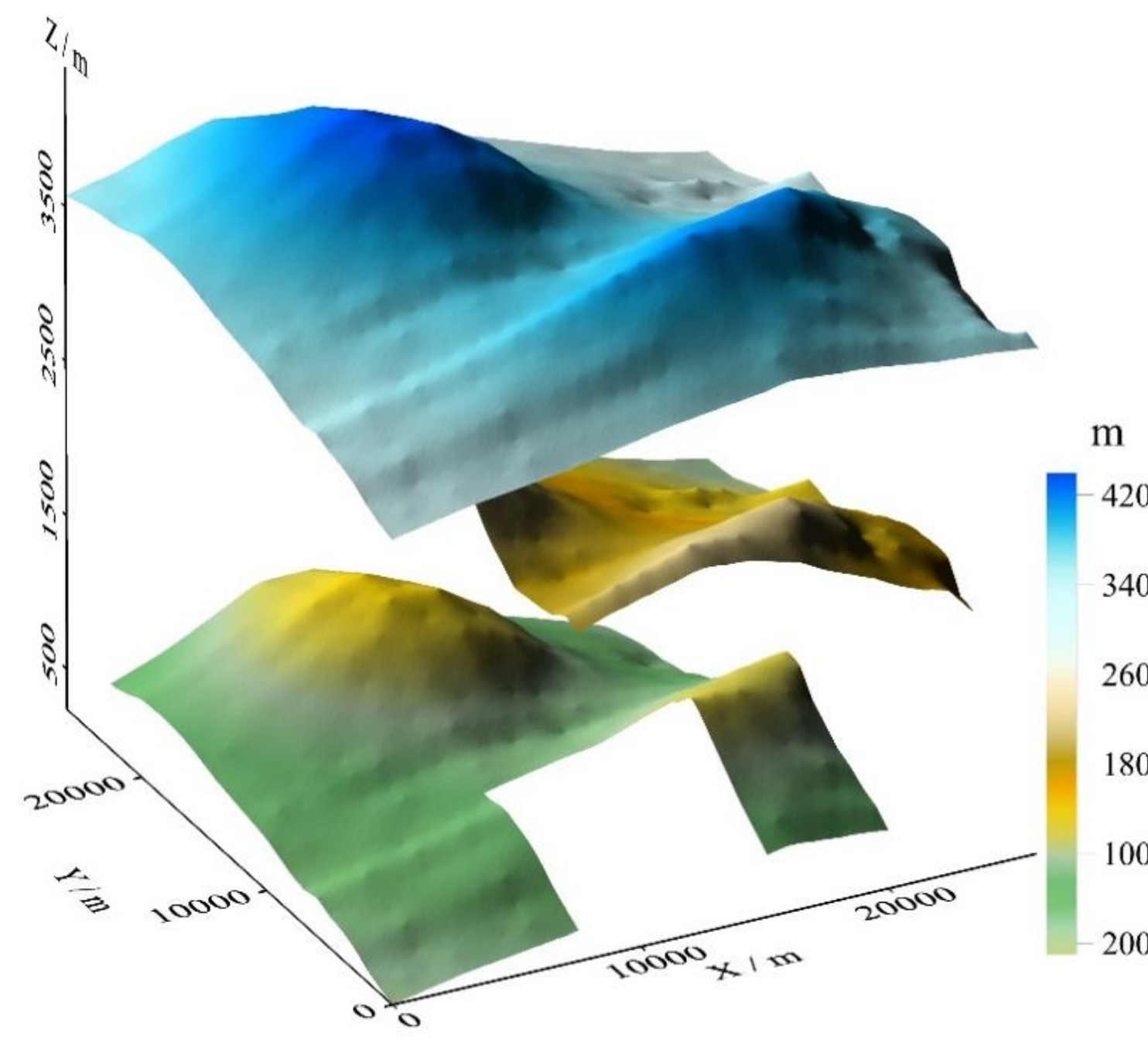Figure 2. Schematic diagram of model location

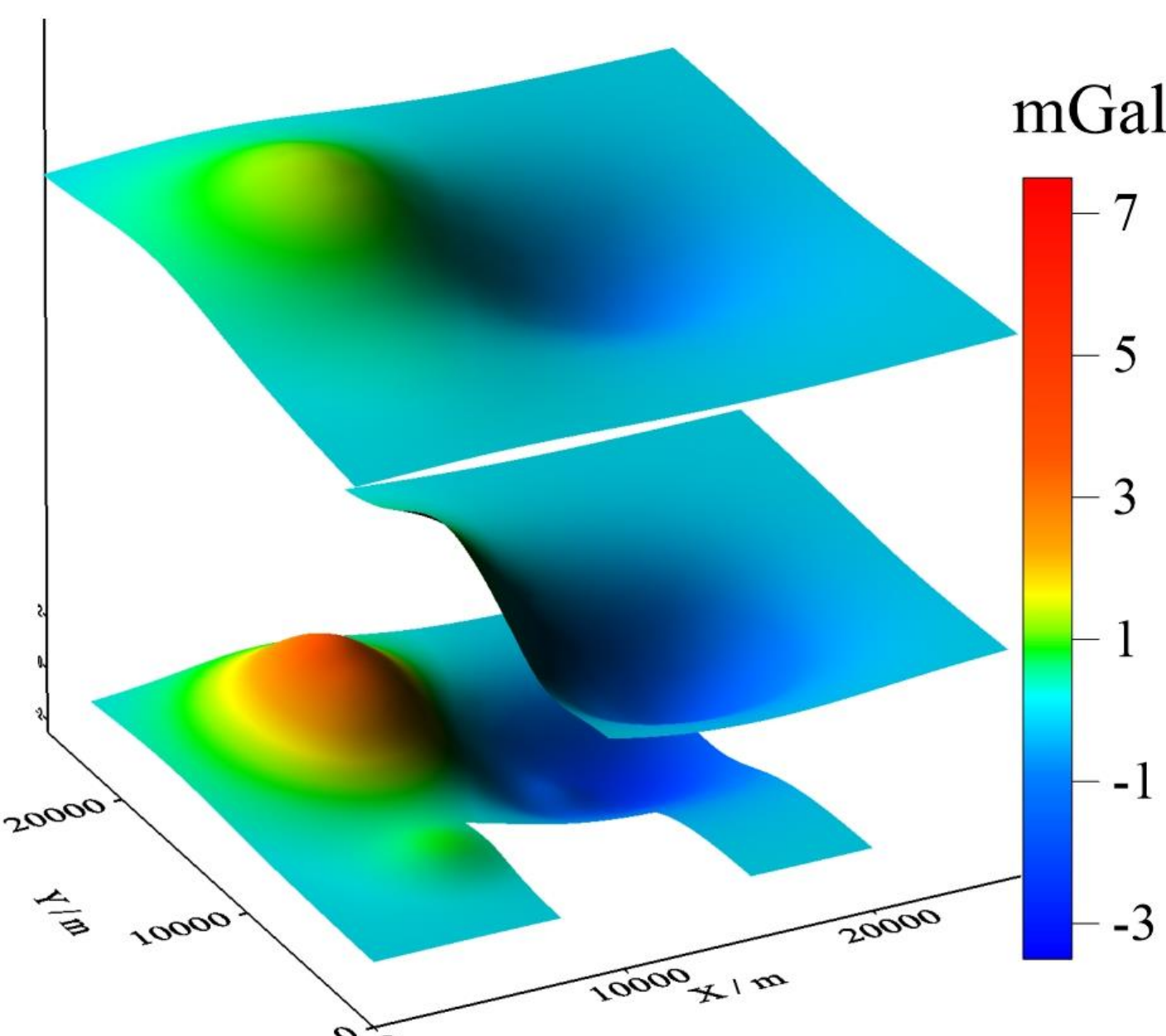

Figure 3. Multi-dimensional observation surface

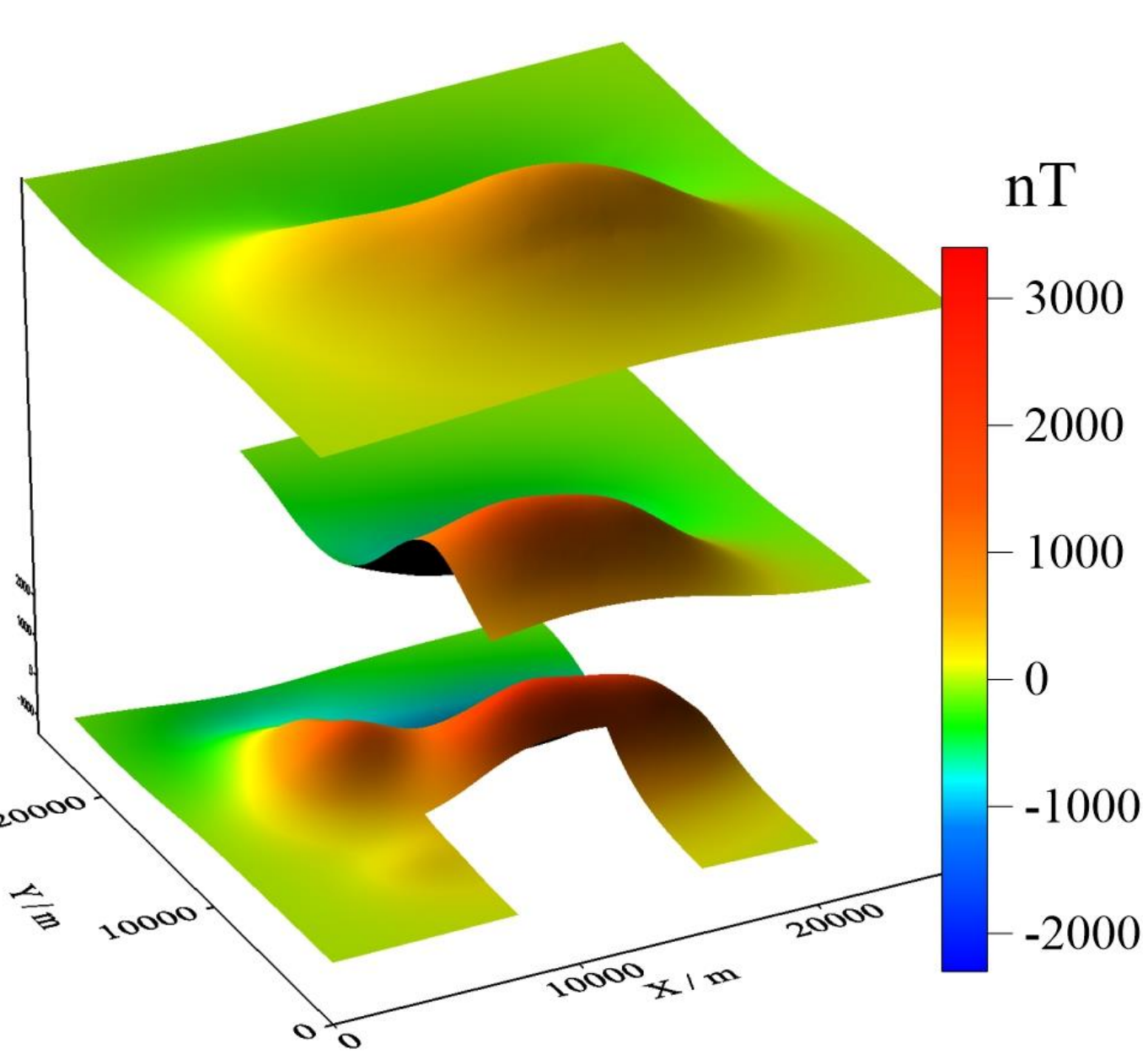Figure 4. Gravity anomalies on the observation surface

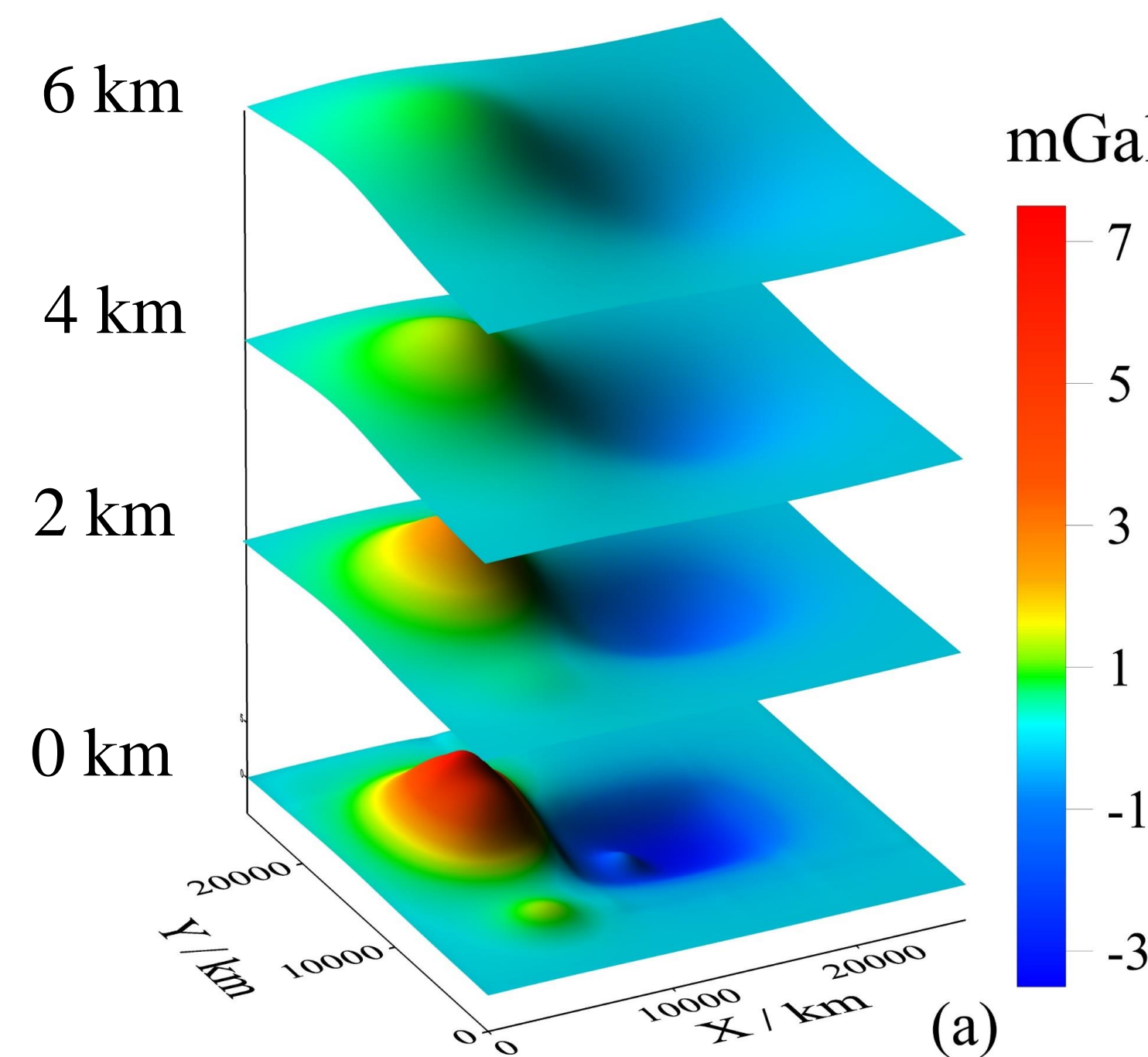Figure 5. Magnetic anomalies on the observation surface
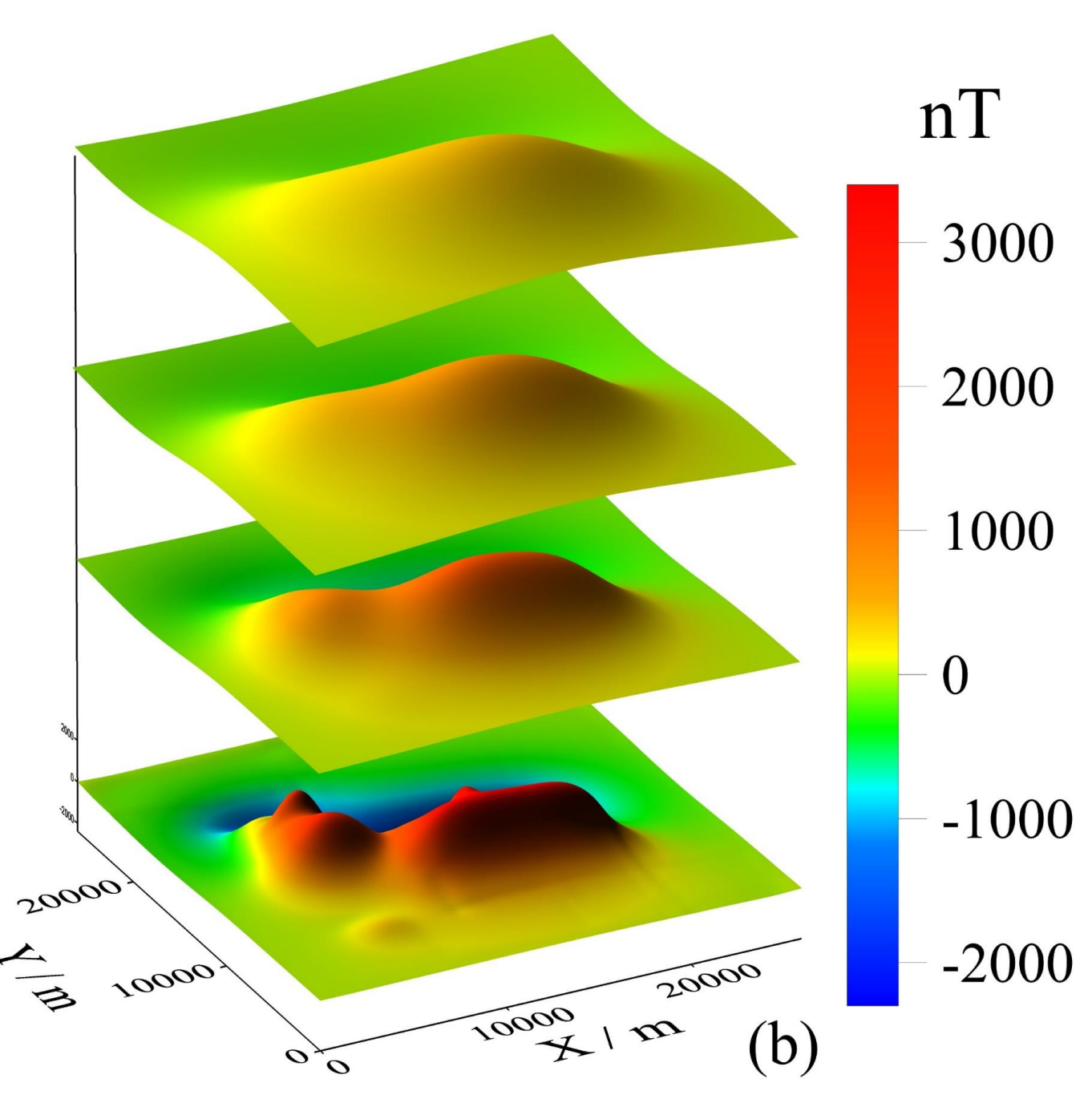

Figure 6. Fusion gravity anomalies

Figure 7. Fusion magnetic anomalies

Error	Gravity Anomalies（mGal）				Magnetic Anomalies（nT）			
	0km	2km	4km	6km	0km	2km	4km	6km
Average error	0.006	0.001	0.003	0.005	0.113	0.016	0.389	0.595
RMS Error	0.064	0.012	0.009	0.010	21.64	0.742	1.157	1.806
Relatively RMS Error (%)	0.847	0.428	0.652	1.298	0.653	0.050	0.205	0.412

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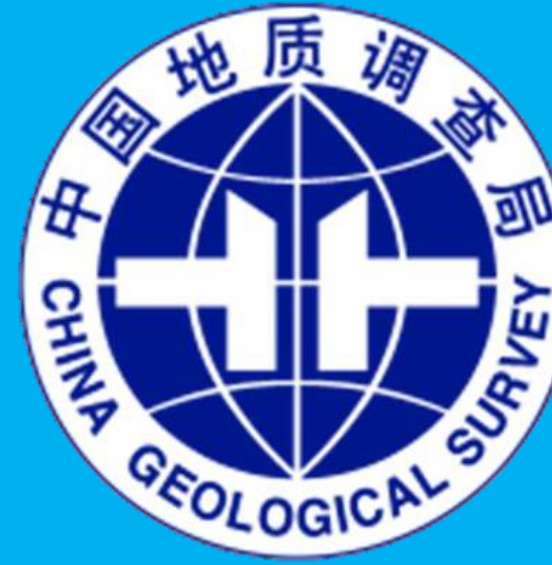
Xiaolin Ji[1] ，Wanyin Wang[1]，Fuxiang Liu[1]，Min Yang[1,2]，Shengqing Xiong[3]，Jie Ma[1]

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Real Data

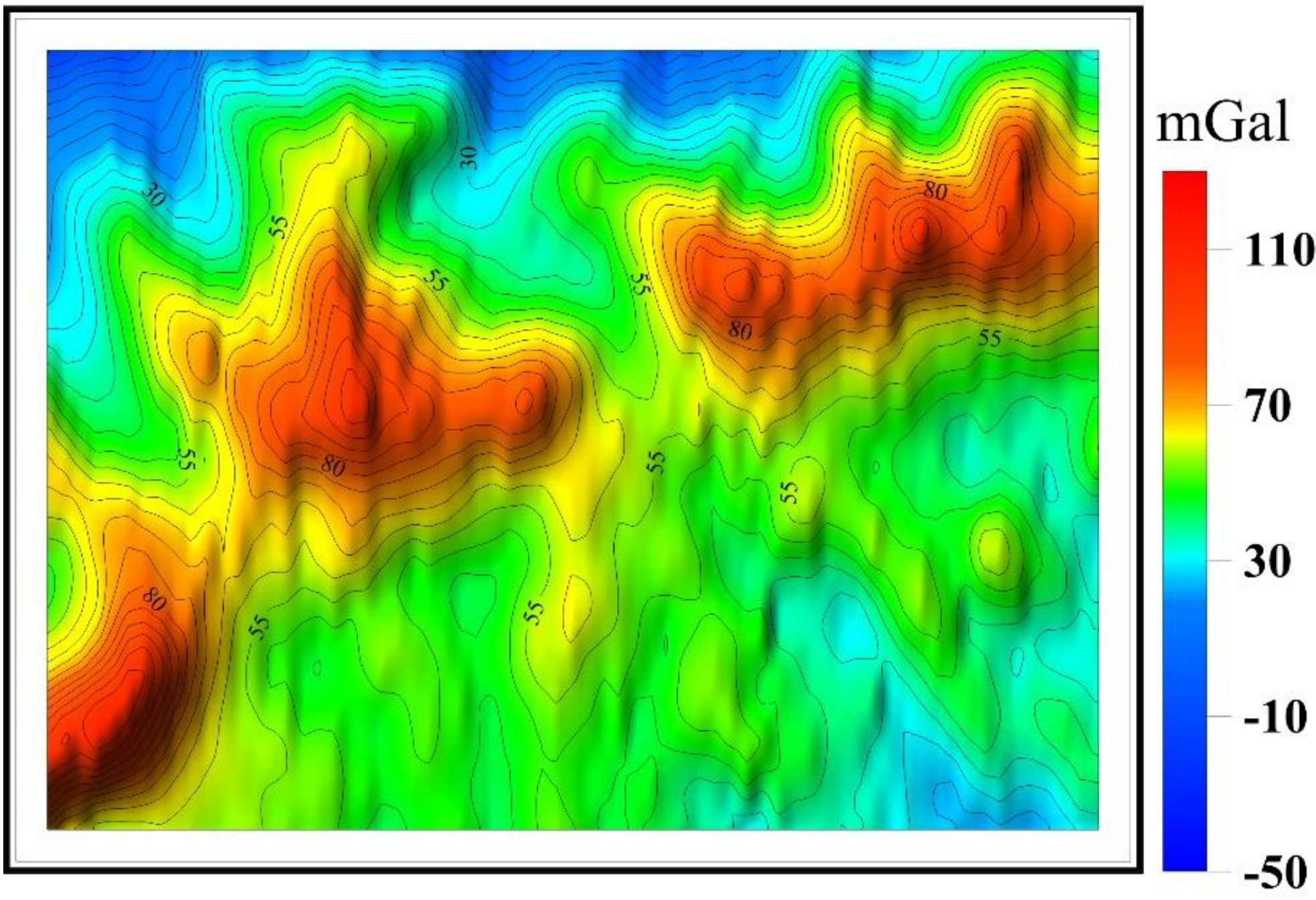### （1）Real gravity anomaly data

Figure. 8 Aeronautical gravity anomaly(Scale:1:50,000)
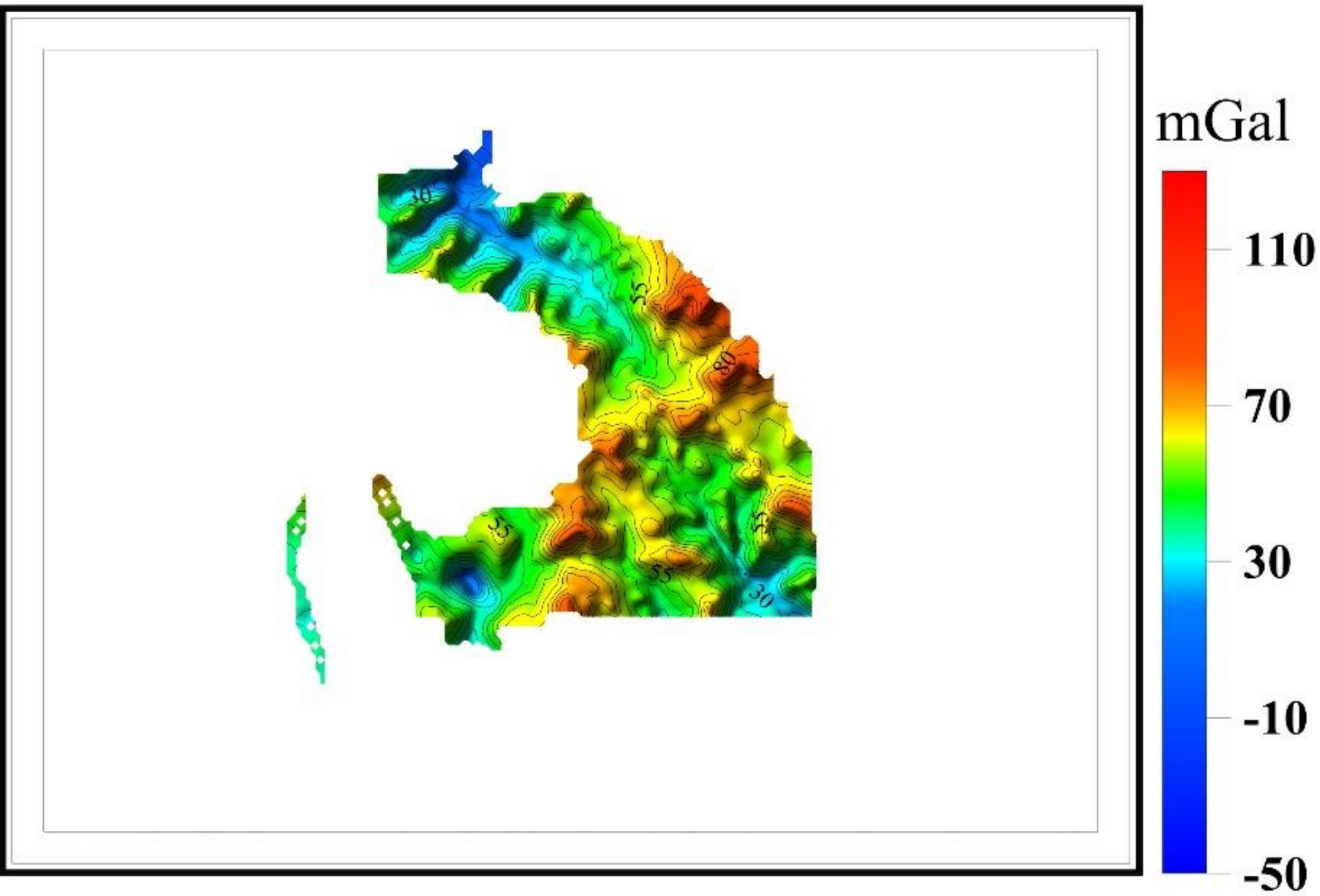

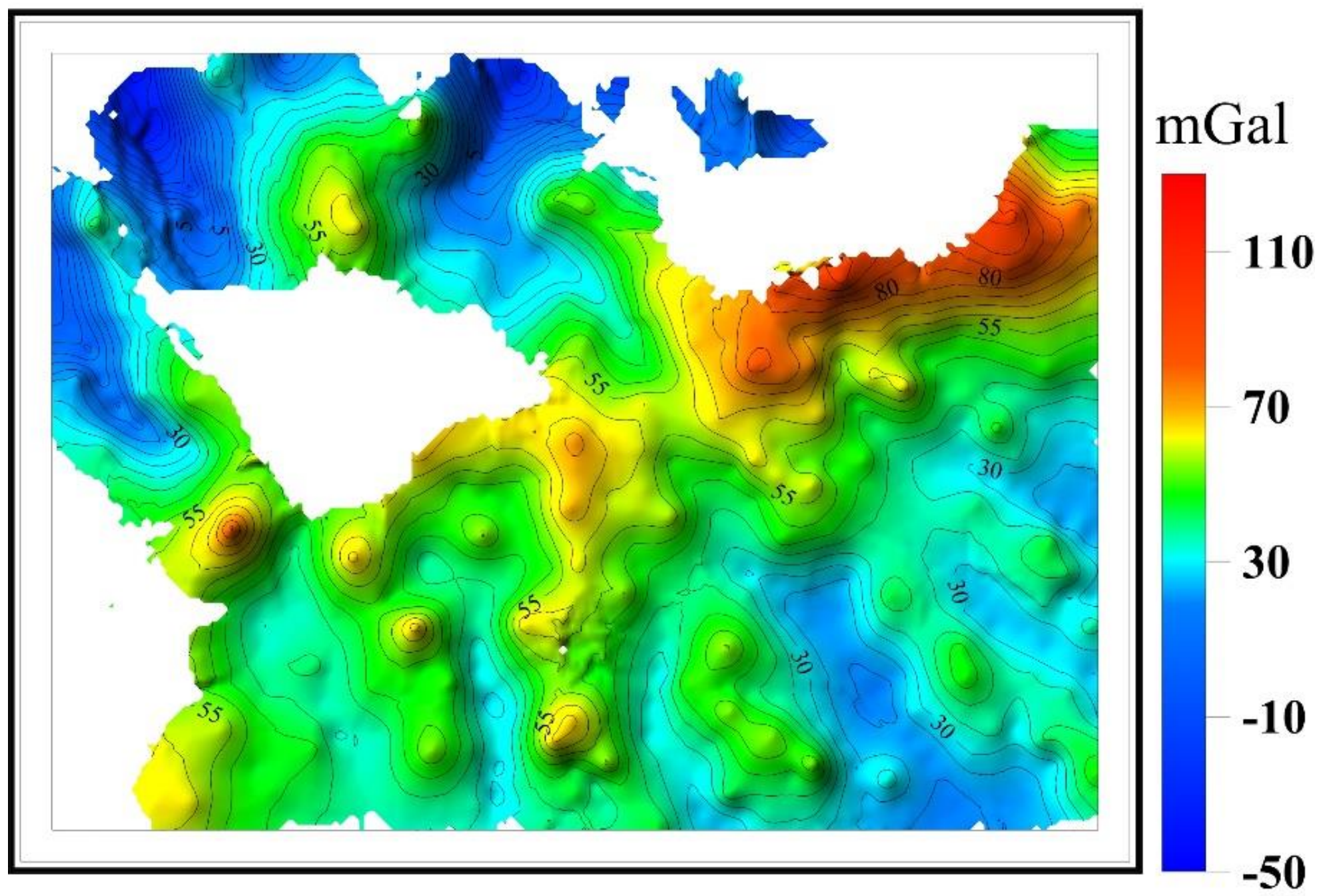Figure. 9 Ground gravity anomaly(Scale:1:50,000)

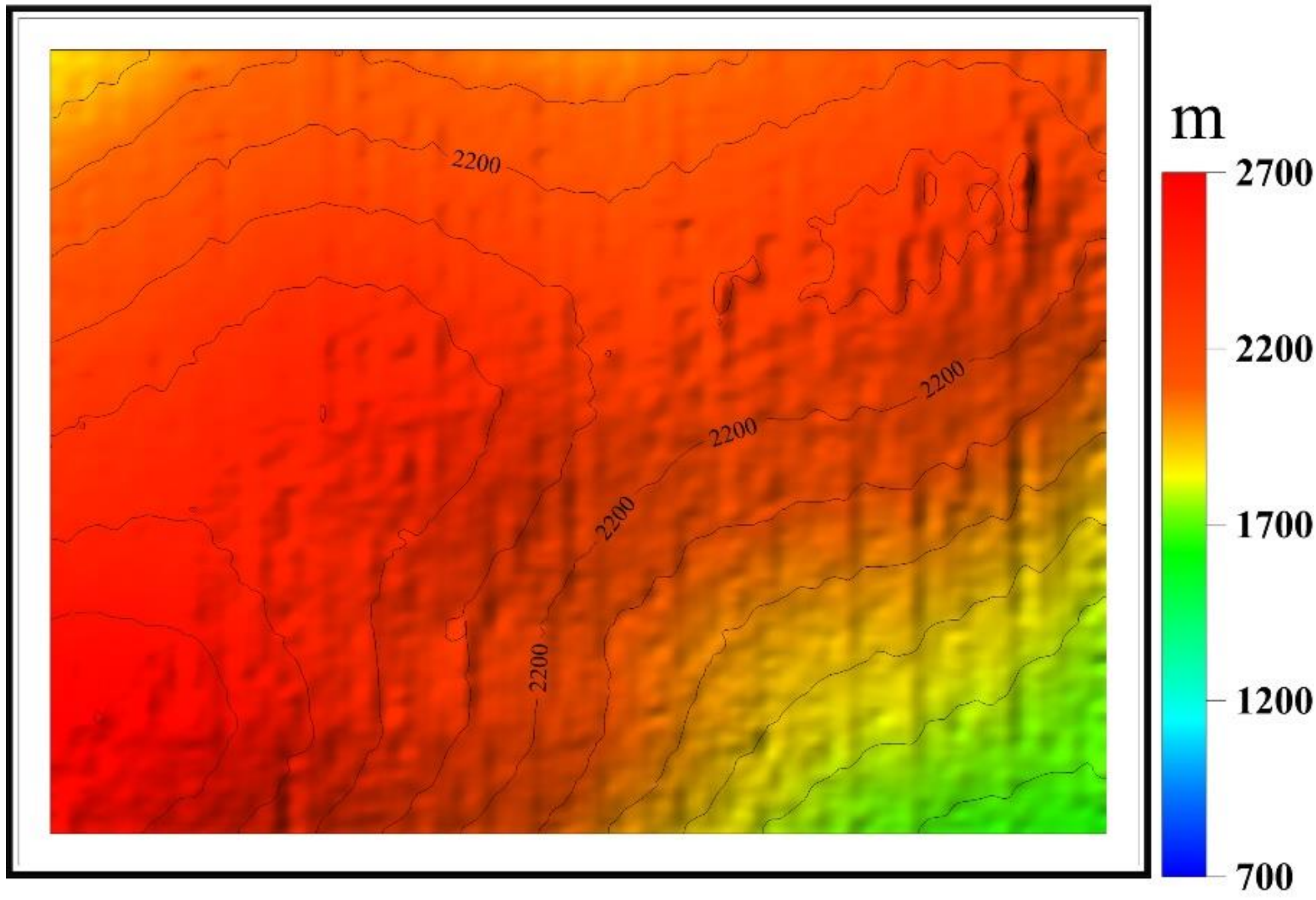Figure. 10 Ground gravity anomaly(Scale:1:200,000)

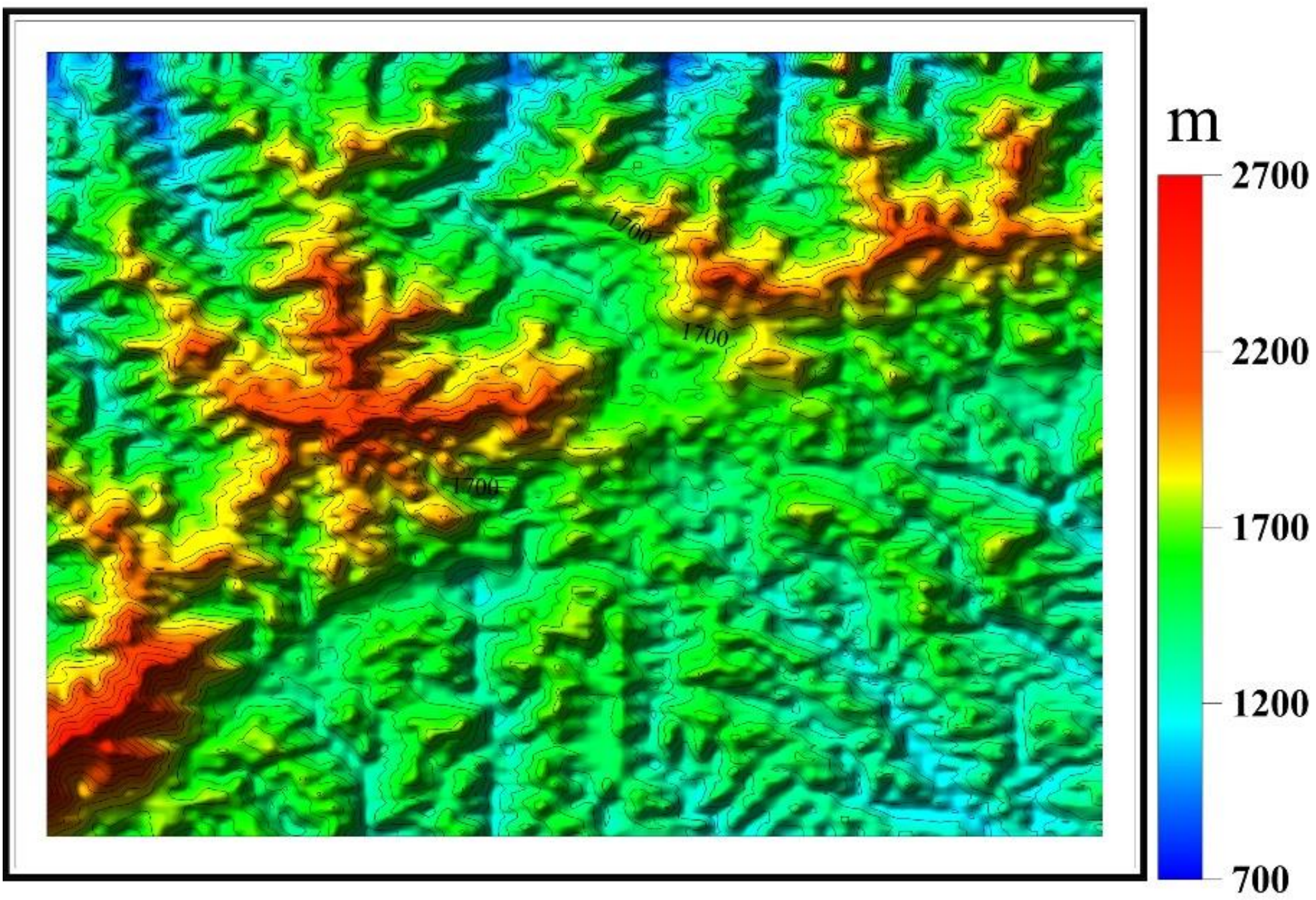Figure. 11 Observation surface of the aeronautical gravity

Figure. 12 Observation surface of the ground gravity

Statistical Items	multi-dimensional and multi-scale	multi-dimensional and multi-scale	multi-dimensional and multi-scale
Correlation Coefficient	0.8835	0.8888	0.9133
Mean Deviation （mGal）	-0.017	4.91×10^{-6}	2.81×10^{-5}
RMS Deviation （mGal）	7.546	7.379	6.556
Relatively RMS Deviation （%）	6.968	6.813	6.054

The test of single-dimensional and multi-scale fusion are used the two ground gravity data whose scale are 1:50,0000 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 1:50,0000(Figure 14). The test of multi-dimensional and multi-scale fusion are used the two ground gravity data whose scale are 1:50,0000 and 1:200,000 and the aeronautical gravity data whose scale is 1:50,0000(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.
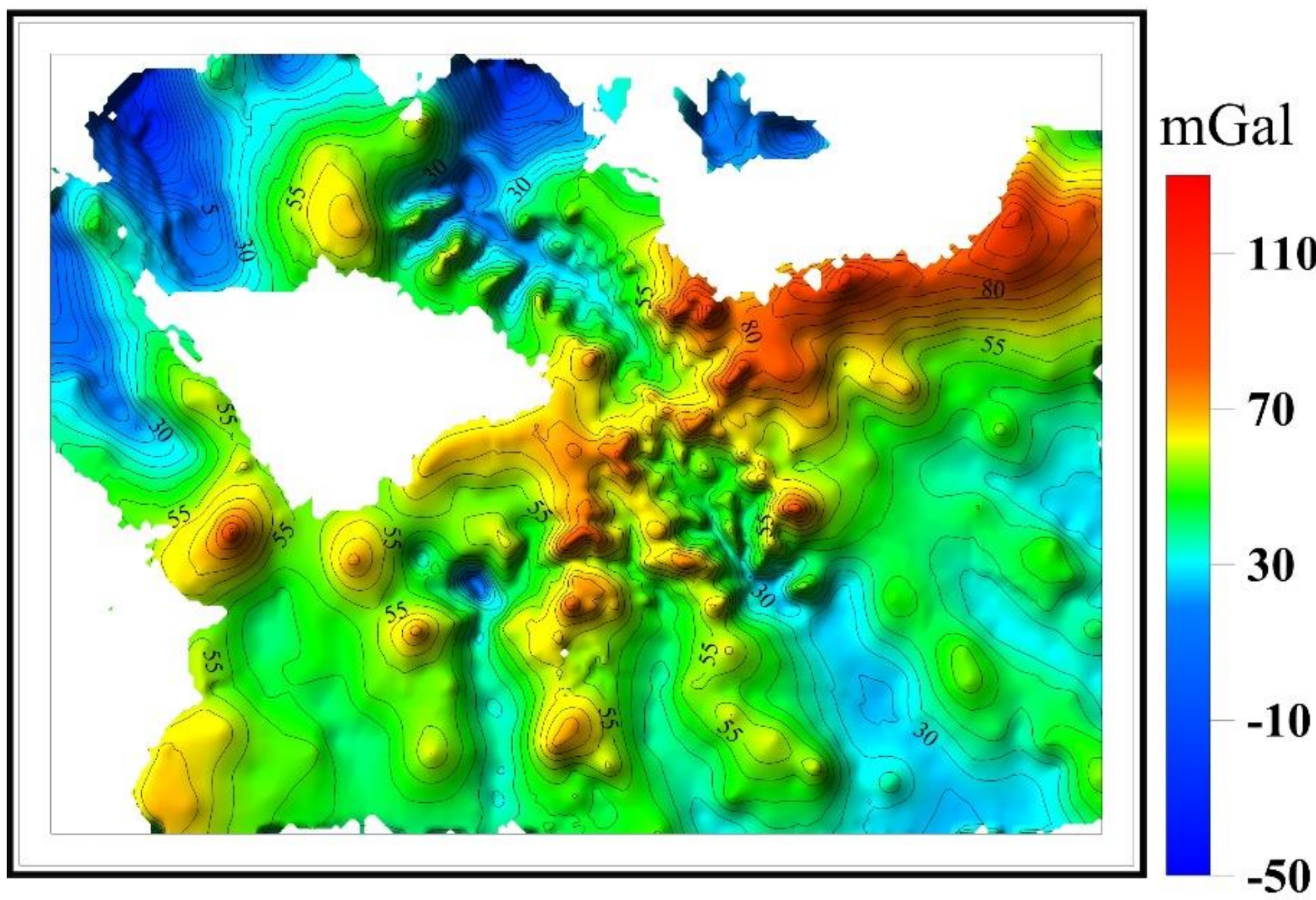
（2）Single-dimensional and multi-scale fusion test

Figure. 13 Fusion gravity using the two ground gravity data whose scale are 1:50,0000 and 1:200,000

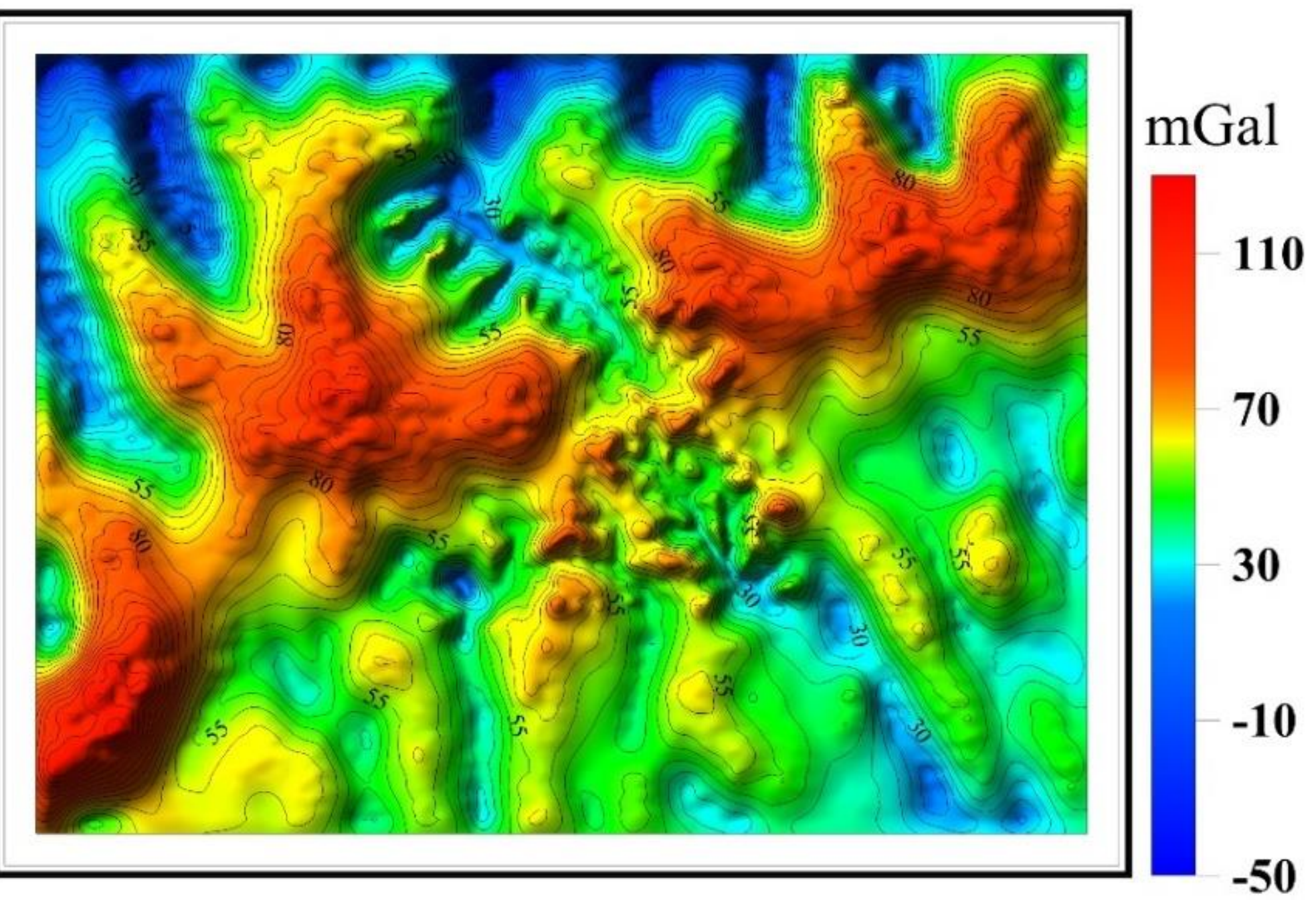### （3）Multi-dimensional and single-scale fusion test

Figure. 14 Fusion gravity using the aeronautical gravity data and the ground gravity data whose scale are all 1:50,0000

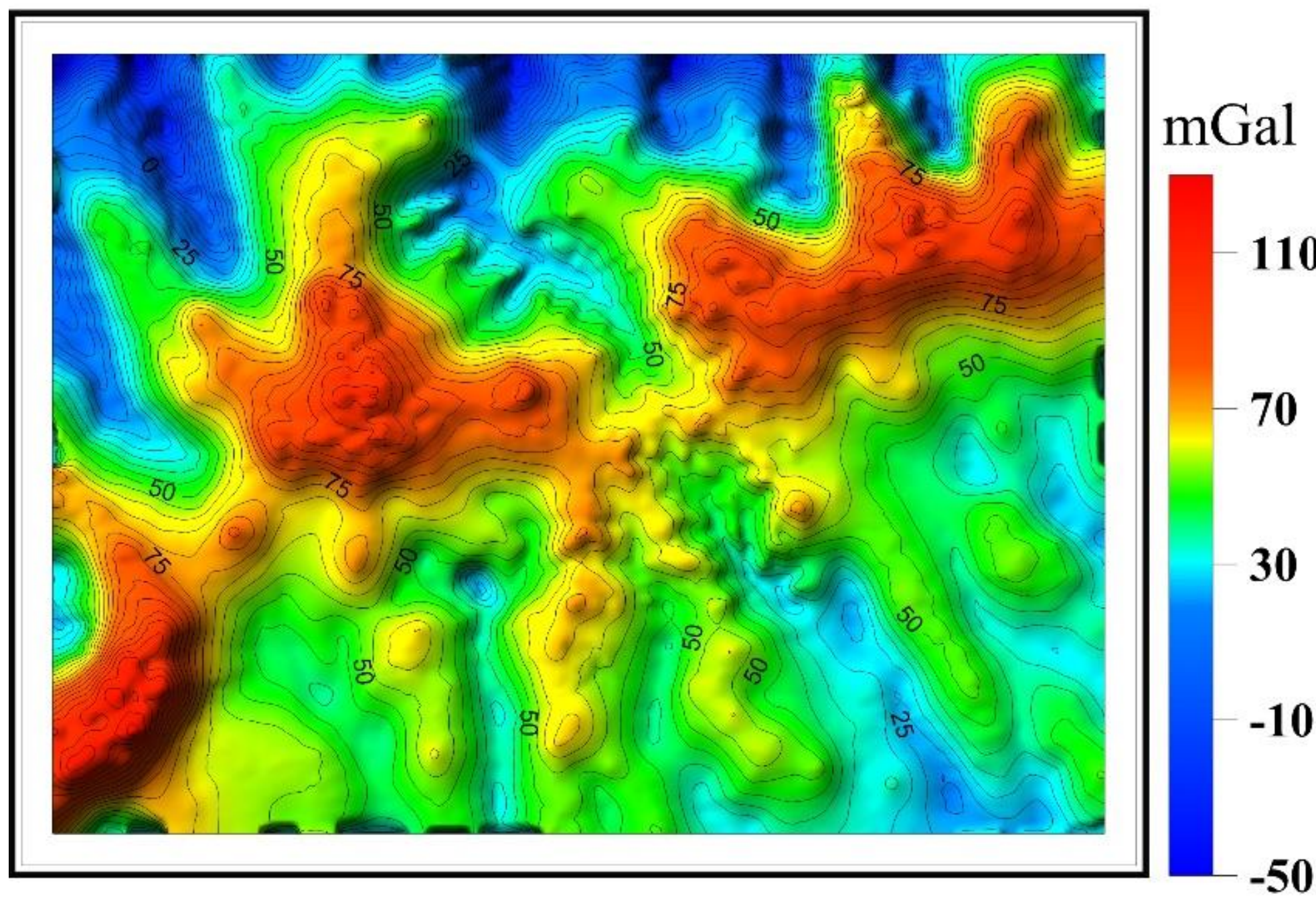### （4）Multi-dimensional and multi-scale fusion test

Figure. 15 Fusion gravity using the two ground gravity data whose scale are 1:50,0000 and 1:200,000 and the aeronautical gravity data whose scale is 1:50,0000

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 aen a certain place of China. The fusion workflow we proposed has good practical significance and promotion value.

References

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[2] Wangyin Wang, Zhiyun Qiu, et al. The research to the extending edge and interpolation based on the minimum curvature method in potential field data processing. *Progress in Geophysics.(in Chinese)*, 2009, 24(4):1327-1338.

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