



A new method for source location and attribute recognition based on correlation analysis of gravity and magnetic anomaly

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1 Background

How to effectively and quickly identify the distribution and attribute of rock mass is an important research of gravity and magnetic interpretation

Gravity and magnetic correspondence analysis-GMCA (Garland, 1951; Cordell and Taylor, 1971; Chandler et al, 1981)

Key technique: Pearson correlation & sliding window

Be widely used by Frese et al, 1982; 1997a,b; Chandler and Malek, 1991; Liu, 1993; Price et al, 1994; Mendonça, 2004; Zeng et al, 2006; Mendonça and Meguid, 2008; Liu et al, 2008; De Ritis et al, 2010; Fan et al, 2012

Disadvantage: high correlation outside the field source area
difficult to be interpreted
may lead to wrong conclusions

2 New method



We propose a new parameter to overcome the disadvantage of the traditional GMCA

Gravity and magnetic correlation parameter (GMCP)

Key techniques:

Pearson correlation

Vertical derivative of potential field

Sliding window

2 New method

the calculation steps

① normalization

$$NVDR_g(x,y) = \frac{VDR_g(x,y)}{\max(|VDR|_g(x,y))}$$

$$N RTP(x,y) = \frac{RTP(x,y)}{\max(|RTP|(x,y))}$$

② Person correlation

$$CC(x,y) = \frac{cov(VDR_g, RTP)}{\sqrt{D(VDR_g)}\sqrt{D(RTP)}} = \frac{\sum(VDR_g - \mu VDR_g)(RTP - \mu RTP)}{\sqrt{\sum(VDR_g - \mu VDR_g)^2}\sqrt{\sum(RTP - \mu RTP)^2}}$$

③ GMCP calculation

$$GMCP(x,y) = \begin{cases} \frac{|NVDR_g(x,y)| + |N RTP(x,y)|}{\max(|NVDR_g| + |N RTP|)} \cdot sign(CC(x,y)) & |CC| \geq threshold \\ 0 & |CC| < threshold \end{cases}$$

CC: Pearson correlation

VDR: Vertical derivative

RTP: Reduction-to-pole magnetic

cov: covariance

D: variance

μVDR_g : mean of VDR_g in one window

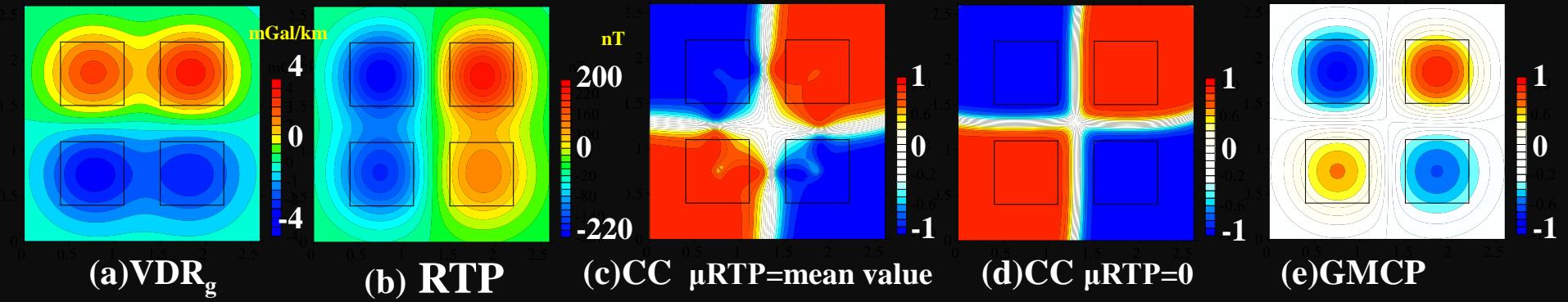
μRTP : mean of RTP in one window

N~: normalized

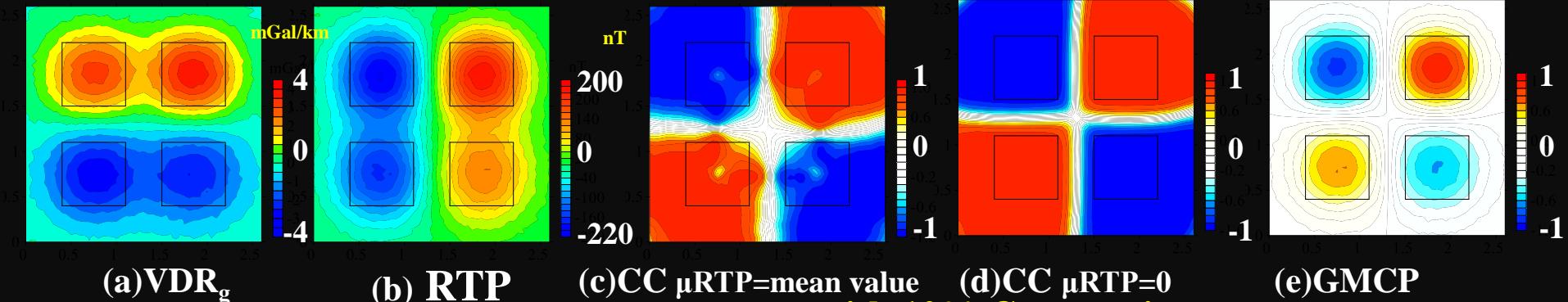
x,y: coordinates of the calculation point

3 Model test

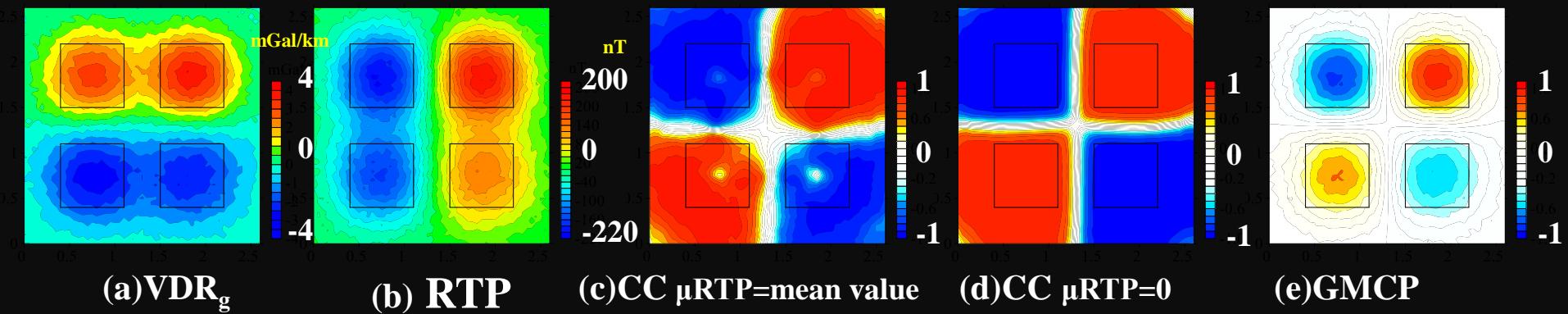
◆ Model 1- Homologous without any noise



with 5% Gauss noise



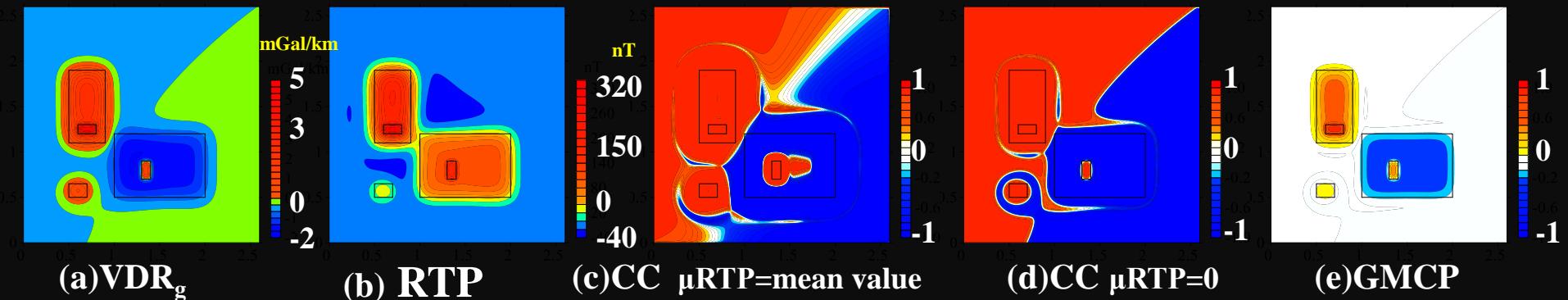
with 10% Gauss noise



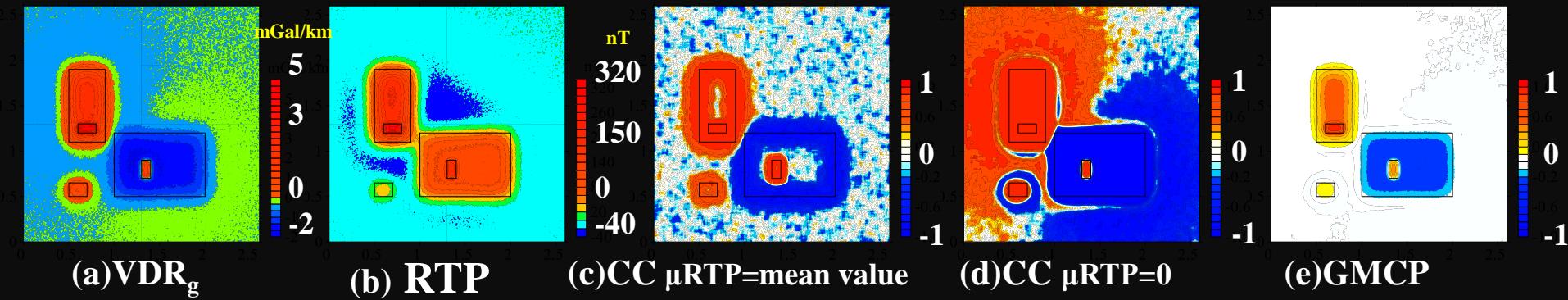
3 Model test

◆ Model 2- Homologous

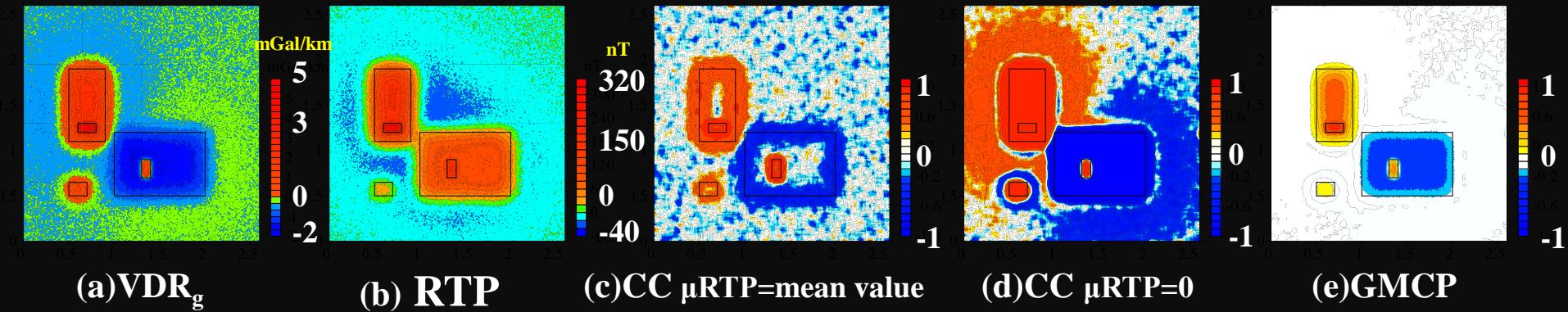
without any noise



with 5% Gauss noise



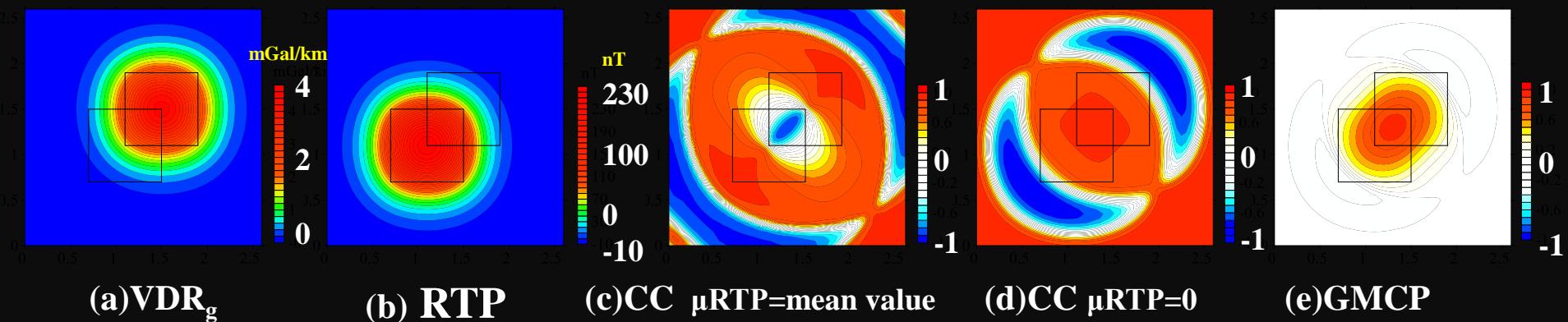
with 10% Gauss noise



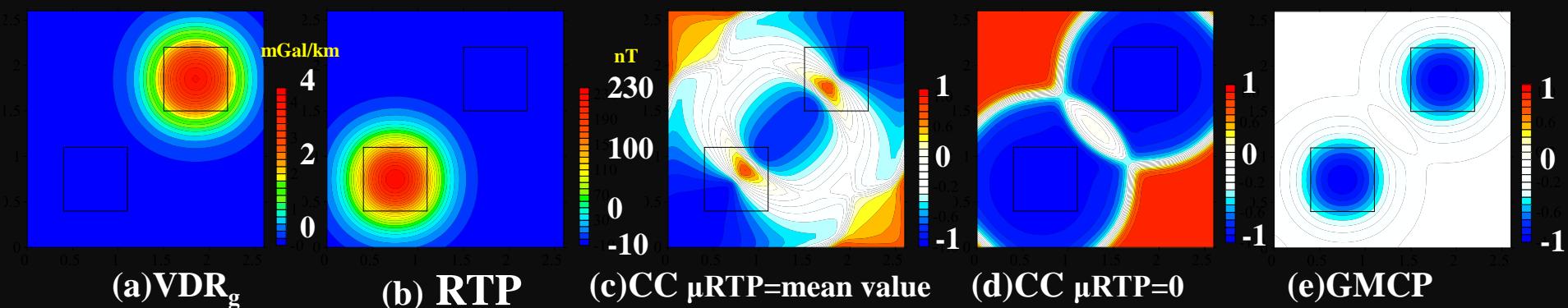
3 Model test



◆ Model 3- Partly-homologous without any noise



◆ Model 4- non-homologous without any noise

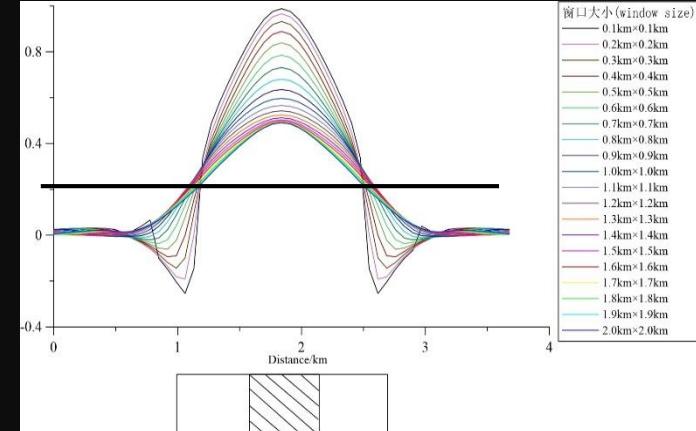
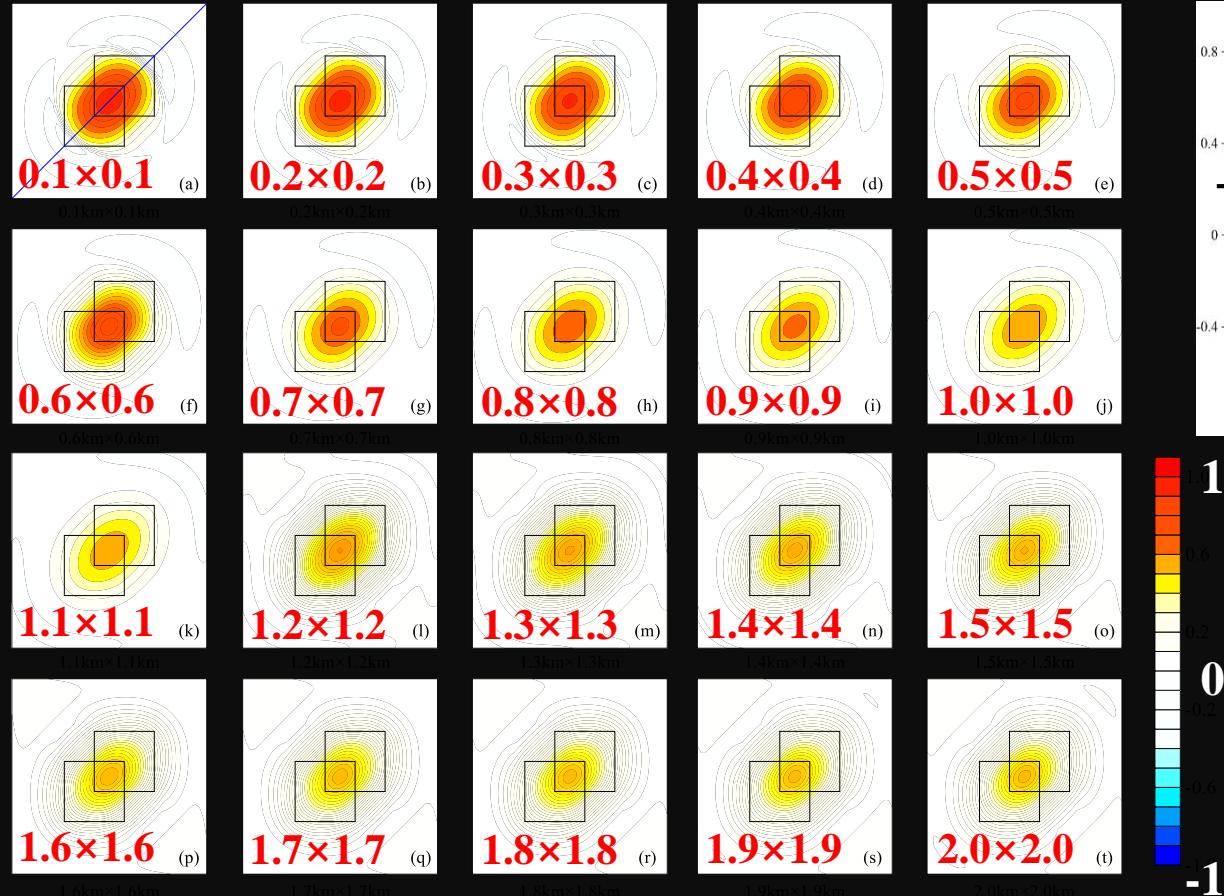


3 Model test



◆ window size impact

Model 3



GMCP>0.2
Indicates horizontal location of the target

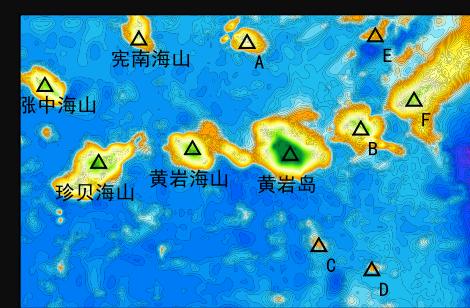
Window size is no more than half of the length of the geological body to be explored

4 Application

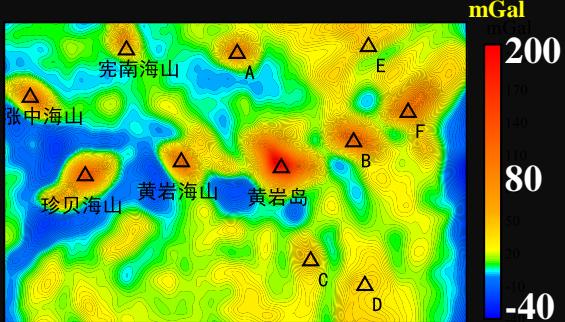
To identify the basalt seamount



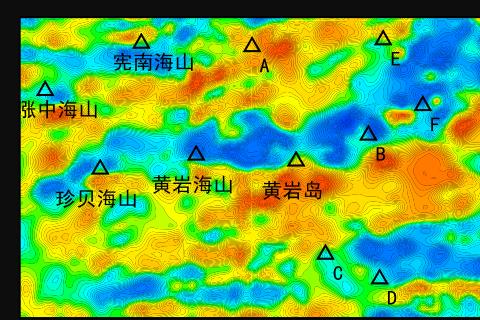
◆ Central of South China Sea



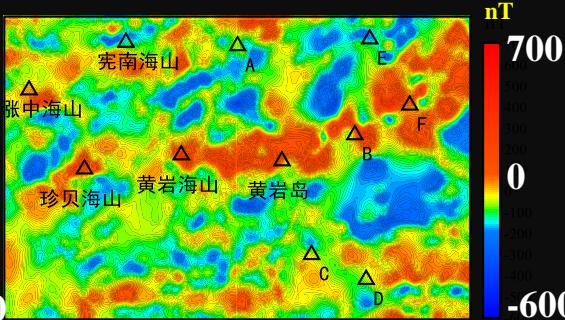
Terrain (from UCSD)



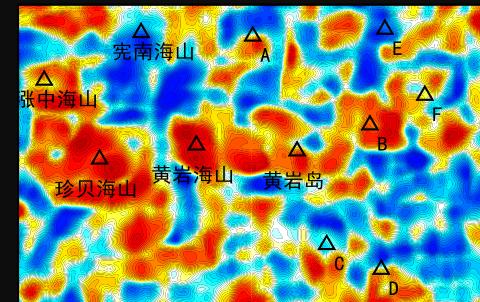
FA gravity (from UCSD)



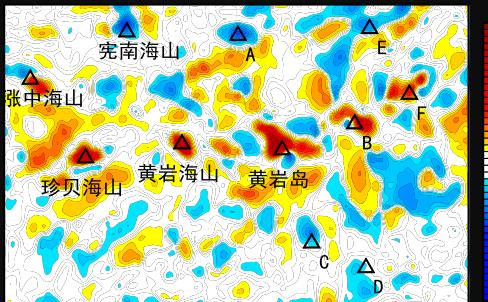
Magnetic anomaly(CCOP)



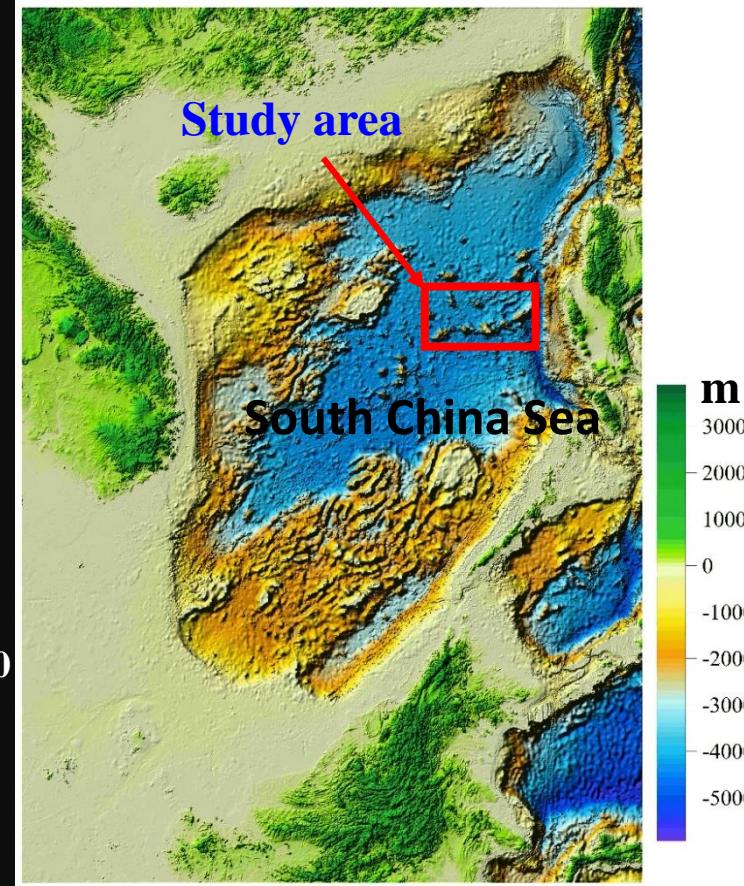
RTP(derived from CCOP)



GMCA



GMCP(this study)



Terrain in South China Sea
(data from UCSD)

5 Conclusion



- ◆ Propose a new parameter(GMCP) to identity the sources (Horizontal location and attribute)
- ◆ Overcome the disadvantage of the traditional GMCA
- ◆ Make the interpretation more easier, compared with GMCA
- ◆ When $|GMCP| > 0.2$ indicates the gravity-magnetic homologous geological body
- ◆ GMCP goes to zero, which means no gravity-magnetic homologous geological body
- ◆ Also, suitable to the vertical second derivative of gravity anomaly and the vertical first derivative of RTP

Thanks!