Lithologic identification & mapping test based on 3D inversion of magnetic and gravity

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Abstract

Though lithologic mapping to achieve ore concentration district transparent within 5km depth is the main way to realize deep fine structures study,to explore deep mineral resources and to reveal metallogenic regularity of large-scale ore district . Owing to the wide covered area, high sampling density and mature three-dimensional inversion algorithm of gravity and magnetic data, so gravity and magnetic inversion become the most likely way to achieve three-dimensional lithologic mapping at the present stage. In this paper, we take Lu-zong(Lujiang county to Zongyang county in Anhui province ,east China) ore district as an example, we proposed lithologic mapping flow based 3D inversion of gravity magnetic and then carry out the lithologic mapping test. Based on the analysis of relations between lithology and density and magnetic susceptibility, 3D inversion with prior information of high-precision gravity and aeromagnetic data were carried out. Then, we use logical topology operations between density 3D model and susceptibility 3D model obtained three-dimensional distribution of five main type lithologies in the Lu-Zong ore district within 5km depth. The result of lithologic mapping not only showed that the shallow characteristics and surface geological mapping are basically Coincide， more importantly reveals the deeper lithologic changes，it make up the insufficient of surface geological mapping. The lithologic mapping test results in Lu-Zong ore concentration district showed that lithological mapping using 3D inversion of gravity and magnetic is a effective method to reveal the lithological characteristics and to explore deep mineral resources in ore concentration district.

1 Methodology

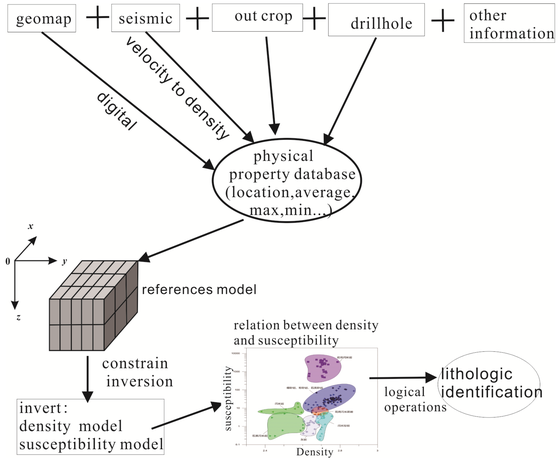
1). Analysis relations between lithology and density and magnetic susceptibility by cross plot.

2).Extracting appropriate residual anomalies from high-precision Bourger gravity and aeromagnetic.

3).Use same mesh, do 3D magnetic and gravity inversion respectively under prior information constrained, and then invert susceptibility and density 3D model.

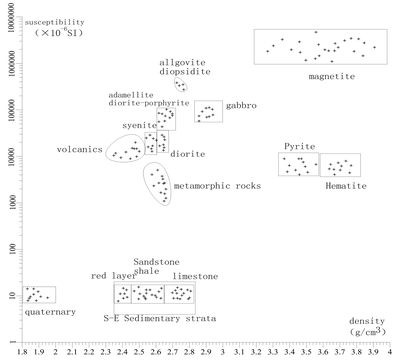
4). According setp1, construct logical topology operations between density 3D model and susceptibility.

5).Use the logical operations, identify lithogies cell by cell in 3D mesh, and then get 3D lithological model.



Flow chart of lithologic mapping based on prior information constrained 3D gravity and magnetic inversion

2 Relationship between physical properties and lithology

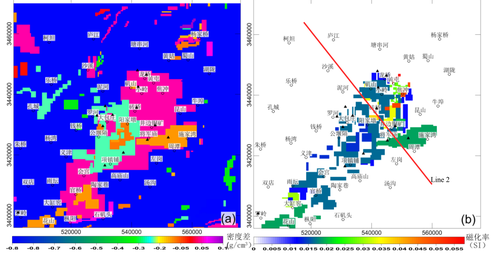


Crossplot of density,susceptibility and lithology in Luzong ore district,China

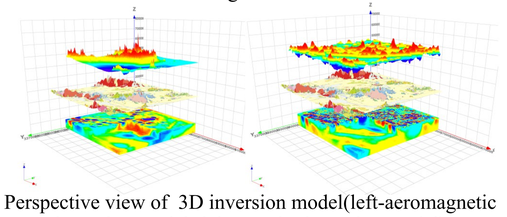
According to rock physical property data set of Luzong ore district，we statistics the magnetic susceptibility and density of main rock types and draw crossplot of density,susceptibility and lithology (as left figure show).According to the crossplot analysis can be found different lithology corresponding to the different density and susceptibility combinations, it proofed that we can identify lithology by density and susceptibility combinations.

3 Gravity and magnetic 3D inversion based on prior information

We convered lithological unit of surface geological map to physical propeties unit and gives these information to cells for three-dimensional inversion,then,set up weight model, reference model and boundary model.constrained by these three models , obtaining 3D distribution model of density difference and magnetic susceptibility by 3D gravity and magnetic inversion.



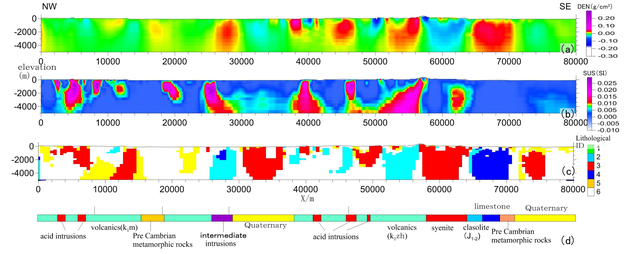
References model for 3D inversion ,(a)-for gravity,(b)-for magnetic



Perspective view of 3D inversion model(left-aeromagnetic inversion model,right-gravity inversion model)

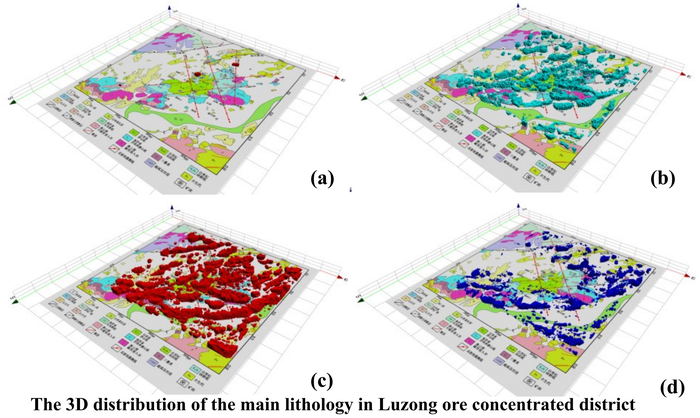
4 Lithologic identification & mapping result

According to the lithology and physical property relations, take logical topology operations between inverted susceptibility model and density difference model cell by cell, gives the corresponding lithologies coding to each cell, achieve lithologic identification and mapping.



The vertical slice map of inversion results, lithologic identity and geology along line 2

(a) Density contrast slice, (b) susceptibility slice, (c) lithologic mapping section:1-ultrabasic rocks, ferromagnetic rocks,2- volcano rock, intermediate rock,3-acid rock mass,A type granite, syenite, 4- high density formation, limestone,5- red layer,mudstone, Quaternary, third sedimentary; 6- un-identify lithology,(d) surface



The 3D distribution of the main lithology in Luzong ore concentrated district

(a): high susceptibility and high density (ultrabasic, ferromagnetic geologic body), (b)middle susceptibility and middle density(Diorite, diorite porphyrite type),(c)low susceptibility and low density(Acidic rock: syenite, granite)，(d) low susceptibility and high density