可控源音频大地电磁测深法寻找隐伏金属矿的作用

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与常规电法相比,可控源音频大地电磁测深法具有探测深度大、设备使用相对轻便和横向分辨率高等特点,已广泛应用于矿产资源勘查工作之中,并取得了令人十分满意的实际效果。这里介绍的是一些具有代表性的实例和应用成果。与常规电法相比,可控源音频大地电磁测深法具有探测深度大、设备使用相对轻便和横向分辨率高等特点,已广泛应用于矿产资源勘查工作之中,并取得了令人十分满意的实际效果。这里介绍的是一些具有代表性的实例和应用成果。电磁测深　危机矿山　隐伏金属矿　定位预测物探化探计算技术黄力军　张威　刘瑞德　[1]中国地质科学院地球物理地球化学勘察研究所　[2]中国地质科学院地球物理地球化学勘察研究所　河北廊坊　[3]河北廊坊2007第六图书馆

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摘 要: 与常规电法相比,可控源音频大地电磁测深法具有探测深度大、设备使用相对轻便和横向分辨率高等特点,已广泛应用于矿产资源勘查工作之中,并取得了令人十分满意的实际效果。这里介绍的是一些具有代表性的实例和应用成果。

关键词: 电磁测深; 危机矿山; 隐伏金属矿; 定位预测
中图分类号: P 631.3+25 文献标识码: A

0 前言

电法在金属矿产物探勘查工作中一直占有重要地位[1~3],随着找矿工作的进一步深入,浅部矿日益减少,寻找深部隐伏矿是今后找矿的主要目标。可控源音频大地电磁测深方法采用定源观测,具有轻便、快速和勘探深度大等优点,在复杂地形条件和深部找矿工作中,确定成矿有利部位,进行隐伏矿定位预测等可起到重要作用。定位预测实际上是指在详查找矿阶段,采用以电测深为主的方法手段对矿 (化)体进行二维或三维空间定位,根据其产状、规模和延伸 (深)情况,结合已知地质和其它资料进行地质解释的一种找矿方法技术。十几年来,我所一直从事可控源音频大地电磁测深应用研究和生产工作,在各个应用领域做过很多工作,作者在本文中通过几个典型实例,介绍可控源音频大地电磁测深方法在寻找隐伏金属矿的勘查工作中的应用效果。

1 已知矿区的应用效果

呷村海相火山岩块状硫化物矿床位于四川西部高原,产于“三江”义敦岛带的昌台火山盆地。含矿围岩为上三叠统呷村组一套中酸性火山岩系,主要岩性有钙质板岩、钙质千枚岩和泥晶灰岩等[4]。

呷村银多金属矿床,主矿体长数公里,局部累计厚度达[illegible]m,向下延伸大于 600 m。图 1(见下页)是呷村矿区主矿体上地质、可控源音频大地电磁测深反演电阻率综合断面图。由图 1可见,可控源音频大地电磁测深反演电阻率低阻异常,基本反映的是良导矿体和赋矿构造在断面内的分布情况,如果应用可控源音频大地电磁测深法面积测量,可以基本勾划出良导矿体和赋矿构造的三维空间分布形态,对该区矿产资源进一步勘探具有明显地指导作用。

2 危机矿山深部找矿

2.1 甘肃白银小铁山矿床深部找矿[5,6]

白银有色金属矿是二十世纪五十年代兴建的我国最大的铜有色金属生产基地,近十年来后备矿源出现危机。1992年我所参与了白银矿区地质和物化探综合找矿研究项目,通过充分研究前人中、大比例尺地质和物化探资料,在小铁山矿区选择成矿有利地段,开展了 100 m ×20 m网度的可控源音频大地电磁面积性测量及重点剖面的岩石地球化学、高精度重磁勘查工作。

小铁山矿为海相火山岩型铜多金属矿床。地表仅有 -处小规模铁帽露头,矿体全部埋藏于深部。区内出露地层为白银群变质火山岩,可分为

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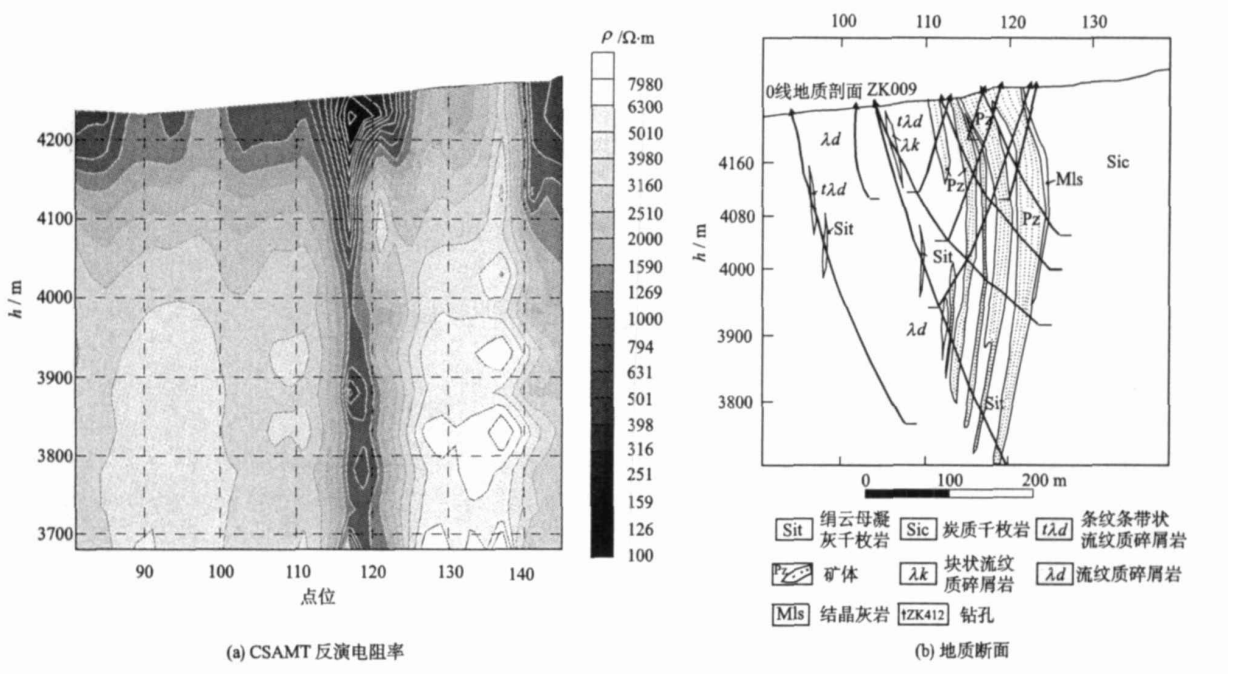


图 1 四川呷村银多金属矿 0线地质物探综合断面图

Fig. 1 Integrated geological and geophysical profile of Line 0 at the Ag - Polymetallic Ore deposit in the Gachun area, Sichuan

上、中、下三层,上部石英角斑岩夹角斑凝灰岩;中部为硅质千枚岩夹石英角斑凝灰岩层,下部为石英角斑凝灰岩层。小铁山含矿带赋矿层一背斜轴部的石英角斑凝灰质碎裂岩中,矿化带上盘为硅质千枚岩,下盘为石英钠长斑岩体。

资料处理后发现,在相距 100 m的 12线和 13线,可控源音频大地电磁测深反演电阻率断面内出现相互对应的二处 (ρ1和 ρ2)低阻异常。其中 ρ1 (ρ1 - 1和 ρ1 - 2)异常对应已知矿体; 12线的 ρ2异常位于深部探矿工程空白地段的 175号点附近,在海拔标高 1 100 m～1 800 m处,为单一低阻异常; 13线的 ρ2异常由 ρ2 - 1和 ρ2 - 2二部分组成,ρ2 - 1异常位于标高 1 400 m～1 700 m处,ρ2 - 2异常位于 ρ2 - 1下方标高 850 m～1 400 m处 (见下页图 2)。

根据地质资料和综合物化探异常,白银有色金属公司地质队 1994年验证了 12线的 ρ2异常。钻孔 (编号 bZK1)揭露 484 35 m～终孔 (724. 02 m),均为矿化蚀变岩和近矿围岩内,其中铜矿化有向下增高趋势, Cu含量平均 0. 04%,最高达 0. 095%,高于矿体近矿围岩含量 (0. 036%)。由于工程故障,钻孔未到设计深度 (800 m)。

之后, 13线布置了 ρ2 - 2异常验证孔 (编号 13 - B2),见厚 17. 7 m,综合品位 (Cu + Pb + Zn)达 17%的工业矿体。由于矿体埋深较大,后来加拿大明科公司在 1 547 m的巷道内连续施工三个定向孔,每个钻孔均见工业矿体[3],矿体的总金属量为 450 00t,这是目前我国矿山深部物化探找矿成功的实例。在小铁山深部找矿工作中,可控源音频大地电磁测深法起到了关键的定位预测作用。

2 辽宁八家子铅锌矿深部找矿[7]

八家子铅锌矿位于辽宁省西部,是具有三十多年开采历史的老矿山,经多年开采,其采矿深度越来越大,同时出现后备矿产资源严重不足。为研究同类矿山深部和外围找矿问题,我们采用目前勘探深度较大的可控源音频大地电磁测深 (CSAMT)方法,在八家子矿区有选择地进行了应用试验研究,以探讨老矿山深部和外围的找矿方法技术。

试验区出露的地层有长城系大红峪组 (chd)、高于庄组 (chg)和中生界侏罗系兰旗组 (Jl)。长城系大红峪组主要为石英岩质砾岩、砂岩、长石石英杂砂岩,局部夹有页岩;高于庄组以白云岩为主,上部为石英质砾岩,局部夹有薄层石英粉砂岩;侏罗系兰旗组岩性为安山质砾岩、安山岩、安山质角岩、集块岩及凝灰岩。区内已知与成矿有关岩浆岩为房胜沟巨斑状花岗岩体 (γ_2)的一部分。

区内构造比较发育,多方向、多期次活动的断裂构造比较复杂,主要控矿构造为吴家屯逆冲推覆构造 (编号为 F_{34})和北北西向的 F_{12}断层。

矿区内近矿围岩电阻率均大于 1000Ω · m,

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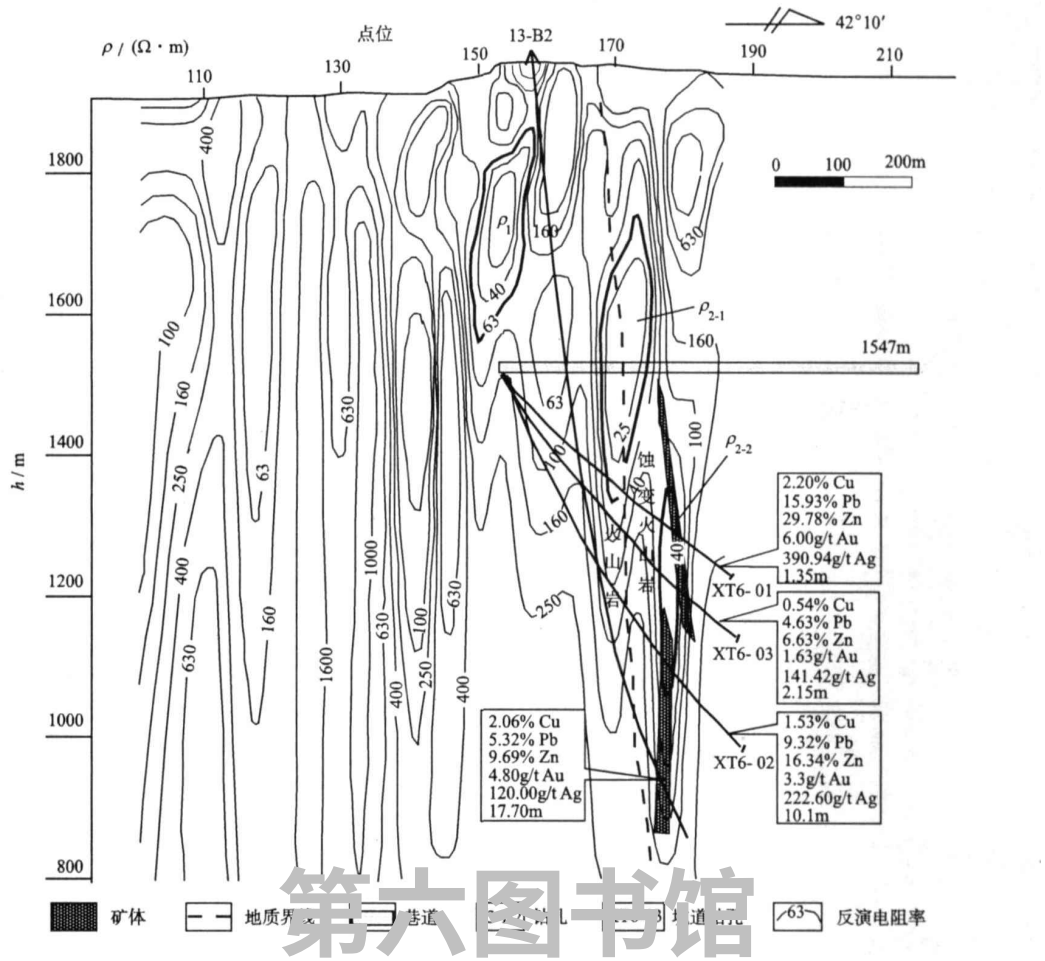


图 2　白银小铁山矿区 13线 CSAMT反演电阻率异常和钻孔验证结果

Fig 2　Inverted resistivity anomalies from CSAMT data along Line 13 in the Xiaotieshan Deposit, Baiyin, and borehole confirmed results

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矿石电阻率为 n ×10Ω · m,岩矿石之间存在较大的电阻率差异,在该区使用电阻率法找矿存在着充分的地球物理前提。

F_{12}断层为逆断层,断层走向 305°左右,倾向北东,倾角 60°～80°。矿体赋存于 F_{12}断层及附近的次级构造中,围岩为高于庄组白云岩,高于庄组白云岩既是赋矿围岩,同时也为成矿提供了部分物质。

图 3是 F_{12}断层矿段 14线 CSAMT反演电阻率断面图。海拔标高 - 300 m以上 F_{12}断层附近的矿体已基本开采完毕,其开采巷道反映出相对高阻,所以标高 - 300 m以上 F_{12}断层按实际地质情况确定, - 300m以下按电阻率分布情况推断。由 14线 CSAMT反演电阻率断面图可见,分别在 35号、53号、78号和 90号点附近出现电阻率横向剧变现象,形成明显的梯度带,推断为断层反映 (按顺序编号为 F_{14}断层、F_{13}断层、F_{11}断层和 F_{10}断层,其中 F_{14}断层、F_{13}断层为已知断层, F_{11}断层和 F_{10}号断层

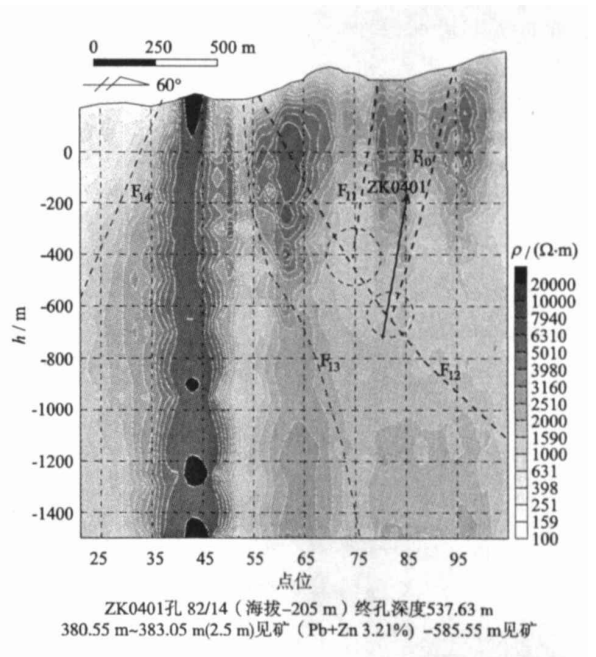


图 3　八家子矿区 F12矿段 14线 CSAMT勘查综合断面图

Fig 3　A CSAMT profile along Line 14 at Block F12 in the Bajiazi Deposit

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为推断断层)。F_{14}断层二侧电阻率差异较大,为侏罗系兰旗组火山岩与长城系高峪庄组大理岩的分界面;F_{13}断层与 F_{12}断层倾向一致,F_{10}断层和 F_{11}断层与 F_{12}断层倾向相反,二断层分别与 F_{12}断层在海拔标高 - 400 m和 - 600 m处相交。二处断层交点附近分别出现二组低阻异常,其中 F_{12}断层与 F_{11}断层交汇处及 F_{11}断层附近的低阻异常为未开采已知矿异常,推断 F_{12}断层与 F_{10}断层交汇处及 F_{10}断层附近的低阻异常为矿致异常。经钻孔验证在 82号点海拔标高 - 585.55 m～ - 588.05 m处见矿,见矿厚度 2.5 m, Pb + Zn品位为 3.21%。

3 隐伏金属矿体的定位预测

3.1 甘肃石居里 I号沟浅部隐伏小矿体定位预测

石居里 I号沟矿点位于甘肃省境内祁连山腹地,海拔 3 600 m以上,属海相火山岩块状硫化物型。矿点紧邻走向 300°～310°区域性断裂,地层为下奥陶阴沟组上岩组,岩性为细碧玢岩、火山角砾岩、细碧凝灰岩、凝灰质砂岩和英安凝灰岩等。

该矿点 1966年填图时发现,以后做过 1∶2 000激发极化、自然电场法和化探土壤测量,发现四处异常。并对其中二处异常进行钻探验证,未发现隐伏矿体,后来民采将地表矿挖尽。1998年应某矿业公司邀请在该区进行找矿工作,我们首先采用中梯装置的时间域激发极化法进行了面积性测量,发现一处长约 200 m的激电异常。随后采用可控源音频大地电磁测深(CSAMT)方法对激电异常进行定位评价,在 6线 87号测点海拔标高 3 750 m处发现与激电异常对应的电阻率异常(见图 4),经综合对比分析推断为矿致异常,据此验证,当年见矿。矿体埋深 43 m,长 18 m,向下延伸 16 m,平均厚 2 m,Cu平均品位大于 8%,现已开采完毕。

在石居里 I号沟,应用 CSAMT圈定了浅部隐伏富铜矿体,其规模虽不大,却证明了该方法的对异常体较高的分辩率。

3.2 内蒙朝不楞深部隐伏铁锌矿体定位预测

内蒙古自治区朝不楞铁锌矿区,地表大部为第四系覆盖。中泥盆统塔尔巴格特组,主要由大理岩、砂质板岩、变质砂岩等组成,是与花岗岩接触交代变质作用形成的矽卡岩型铁、多金属矿床的直接围岩;它除受程度不深的区域变质作用外,更主要是受到热接触变质和接触交代变质作用。除离花岗岩体较远的地层变质较浅外,其余都变质为各种角岩或矽卡岩。在中泥盆统老地层与北东向展布的花岗岩体的外接触带内,赋存有矽卡岩型铁、多金属矿。

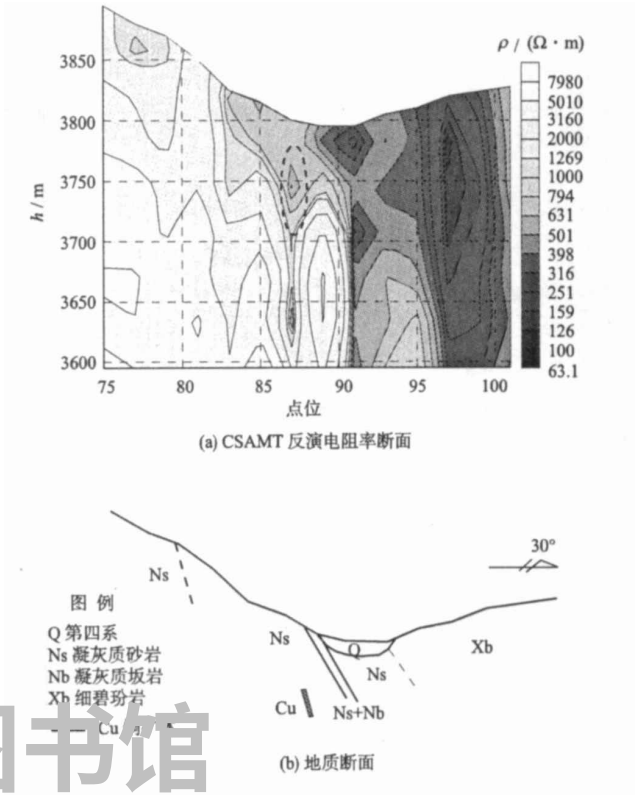


图 4 甘肃石居里 I号沟矿点 6线综合断面图

Fig. 4 Aerial integrated section along Line 6 at the Yihaogou Ore Spot, Shijuli, Gansu

该矿床勘探主要是利用地表槽探揭露和磁法异常查证,对深部情况所知甚少;原有勘探钻孔最深不超过 300 m。2004年底,我们在该区布设了几条控制性的可控源音频大地电磁测深剖面,通过了解区内花岗岩体空间分布情况,进而解决矿区深部找矿问题。

图 5是区内某线可控源音频大地电磁测深勘查综合断面图,由图 5可见,断面内高阻为花岗岩体,在3 400 m～3 800 m测点间出现相对低阻区,3 400 m～3 600 m之间的低阻区内,对应有较弱的磁法异常。根据断面内电阻率的分布情况,结合磁异常和矽卡岩矿床的地质特征,推断岩体局部转折处为矿体赋存有利部位,分别布设 ZK16和 ZK18号查证钻孔。ZK16孔,在 67.14 m～100.64 m处见到厚度达 33.5 m的富铅锌矿体;ZK18孔在 575 m和 625 m深处分别见到厚 5 m和 20 m的富铅锌矿体,使该矿区深部找矿取得了突破性进展。

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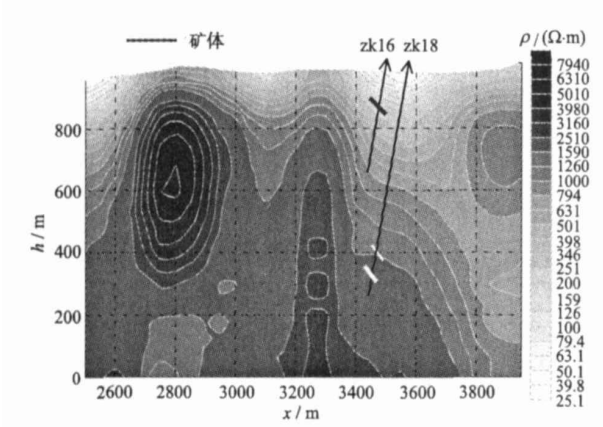


图 5　内蒙古朝不楞矿区某线 CSAMT勘查综合断面图

Fig. 5　A CSAMT section at the Chaobuleng Deposit, Inner Mongolia

4　结语

在有色金属矿区,实际应用结果表明,可控源音频大地电测深法具有勘探深度大,横向分辨率高和设备相对轻便等特点,能够适应地形较复杂地区的矿产资源勘查工作。在成矿有利地段对矿(化)体进行定位预测,结合地质、地球物理特征和其他有关资料进行综合分析,已经取得较好的实际效果。

虽然一些矿(体)与围岩之间没有明显的电阻率差异,但是大多有色金属矿床与岩浆岩体和构造一般关系较密切,利用可控源音频大地电测深法,可通过寻找与成矿有关的岩体和构造,进行间接找矿。

作为一种人工场源电磁法,可控源音频大地电磁测深法测量中不可避免地存在场源效应。所以在实际工作中应根据工作任务,结合实际地质和地层电性分布情况,合理的选择场源方向、收发距和采样频率范围;在保证最佳信噪比情况下,要尽量使所采集的数据处在远区。在数据处理中要注意识别场源效应和静态效应等影响引起的数据畸变,慎重处理这些效应的影响。

虽然可控源音频大地电磁测深法能够适应较复杂的地形条件,满足探测深度较大地质勘查工作要求,但随着勘探深度加大,还必须提高观测和解释精度,以提高方法的实际应用效果。另一方面,引起地下电阻率变化的因素很多,利用可控源音频大地电磁测深法进行勘查,需要结合已知地质、地球物理特征和其他有关资料进行综合分析研究,以提高地质解释效果。

参考文献:

[1] 黄力军,刘瑞德,陆桂福,等. 电法在寻找隐伏金属矿方面的定位预测作用[J]. 物探与化探, 2004, 28(1).

[2] 黄力军,刘瑞德,陆桂福,等. 乌奴格土山铜矿物化探异常特征及外围找矿[J]. 物探与化探, 2004, 28(6).

[3] 黄力军,刘瑞德,陆桂福. 相位激电测深在有色金属矿产勘查中的应用[J]. 物探与化探计算技术, 2006, 28(1): 22.

[4] 吕庆田,侯增谦,赵金花,等. 四川呷村火山成因块状硫化物[illegible]综合找矿模式[J]. 矿床地质, 2001, 20(4).

[5] 黄力军,陆桂福,刘瑞德,等. 综合方法寻找矿山深部隐伏矿的一个成功实例[J]. 地质与勘探, 2004年[增刊].

[6] 胡达骧,徐叶兵,陈群. 明科矿业及金属公司在白银厂地区找矿新进展[J]. 地质与勘探, 1999. 35(2): 1.

[7] 黄力军,陆桂福,张强,等. 八家子铅锌矿电阻率异常特征及深部和外围找矿[J]. 物探与化探, 2005, 29(2).

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gravity anomalies have been analyzed, and with conditions suitable for each method of boundary mapping summarized.

Key words: gravity data; boundary locating; locating error; characteristic value

JIANG'S DUAL FIXED TRANSMITTER LOOP CONFIGRATION FOR DEEP DEPOSIT EXPLORATION

JIANG Bang-yuan (Institute of Geophysical and Geochemical Exploration, CAGS, Langfang Hebei 065000, China). COMPUTING TECHNIQUES FOR GEOPHYSICAL AND GEOCHEMICAL EXPLORATION, 2007, 29 (suppl): 0039

The horizontal magnetic field Hx due to the dual fixed transmitter loops is stronger and more homogeneous than that of conventional large fixed transmitter loop. It is suitable to detect deeply buried and steeply inclined deposits and could be used as a source for surveys in boreholes. So it could be a useful tool for ore prospecting in crisis mines.

Key words: jiang's dual fixed transmitter loop configuration; deep conducting deposit; crisis mines

THREE-DIMENTIONAL INVERSION OF ANOMALOUS DATA OF FIXED-LOOP SOURCE TEM SURVEY

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The feasibility of 3D inversion of anomalous data of fixed loop source TEM survey has been analyzed in the paper, and with the inversion method by using modified generalized inverse briefly introduced. The flow chart of the 3D inversion of anomalous data of fixed loop source TEM survey has also been given. A test inversion result of forward modeling data show that the method is effective.

Key words: fixed loop source; transient electromagnetic method (TEM); three-dimensional inversion of anomalous data

AN ALLICATION OF TEM TO ARCHEOLOGICAL INVESTIGATION FOR METAL FUNERARY OBFECTS

WU Jun-jie, LV Guo-yin, ZHAO Jing-xi (Institute of Geophysical and Geochemical Exploration, CAGS, Langfang Hebei 065000, China). COMPUTING TECHNIQUES FOR GEOPHYSICAL AND GEOCHEMICAL EXPLORATION, 2007, 29 (suppl): 0047

The field procedure, data processing and interpretation of TEM survey with fixed source-loop configuration for metal funerary objects have been briefly introduced in the paper. A case result shows that the TEM with fixed source-loop configuration is effective for archeological investigation for fair-sized metal funerary objects.

Key words: Transient Electromagnetic Method (TEM); fixed source-loop; archaeology; ancient tomb; metal object

AN APPLICATION OF SPECTRUM ANALYZER TO ANALYSES OF EM NOISES IN MINES

LEI Da, LI Xiao-chang, ZHAO Fu-gang, et al. (Institute of Geophysical and Geochemical Exploration, CAGS, Langfang Hebei 065000, China). COMPUTING TECHNIQUES FOR GEOPHYSICAL AND GEOCHEMICAL EXPLORATION, 2007, 29 (suppl): 0051

The technique of collecting electrical and electromagnetic fields mixed with EM noises by using HP89410A spectrum analyzer has been introduced in the paper. The technique has been applied for field measurements of noises in mines. Through field acquisition and spectral analyses of EM noises, the characteristics of the noisy signals could be studied, so providing a basis for developing a data acquisition technique of anti-interference EM survey.

Key words: field measurement; spectrum analyzer; interference signal; electromagnetic field noise characteristic

AN APPLICATION OF CSAMT TO PROSPECTING FOR HIDDEN MINERAL DEPOSITES

HUANG Li-jun, ZHANG Wei, LIU Rui-de (Institute of Geophysical and Geochemical Exploration, CAGS, Langfang Hebei 065000, China). COMPUTING TECHNIQUES FOR GEOPHYSICAL AND GEOCHEMICAL EXPLORATION, 2007, 29 (suppl): 0055

In comparison with conventional electrical methods, CSAMT is characterized by larger detection depth, higher lateral resolution and more portable facilities, and therefore has been widely adopted in mineral explorations, with rather satisfied results obtained. Introduced in the paper are some case histo-

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ries

Key words: EM sounding; mines nearly exhausted; hidden mineral deposit; location prediction

AN APPLICATION OF CSAMT SOUNDING TO EXPLORATION OF DEEP GEOTHERMAL RESOURCES

HUANG Li-jun, MENG Yin-sheng, LU Gui-fu (Institute of geophysical and Geochemical Exploration, CAGS, Langfang Hebei 065000, China). COMPUTING TECHNIQUES FOR GEOPHYSICAL AND GEOCHEMICAL EXPLORATION, 2007, 29 (suppl): 0060

Electrical methods used to be the main tools for exploration of geothermal resources. However, conventional electrical methods have no longer met requirements of practical surveys for geothermal resources as detection depth required becoming deeper and deeper nowadays. In recent years, a large quantity of geothermal surveys has been completed by IGGE with CSAMT sounding, with quite satisfied results obtained. Introduced in the paper are some case histories.

Key words: EM sounding; green energy resources; exploration of geothermal resources

MODELING OF STATIC EFFECT IN CSAMT AND COMPARISON OF DIFFRENT CORRECTION METHODS

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There always exist static effects because of shallow inhomogeneous bodies in controlled source audio - frequecy magnetotellurics (CSAMT), resulting in difficulties in data interpretation. Therefore ii is very important to correct static shift in CSAMT data. Analyses of the static effects have been conducted in the paper through modeling with conductive static models, a comparison has also been made for some correction methods selected. Because of the existence of shallow inhomogeneous bodies in CSAMT (Controlled source audio - frequency magnetotellurics), static shift always occurs, which makes the interpretation of CSAMT data very difficult, or even impossible. So it is very important to correct static shift in the interpretation of CSAMT data. In this paper, the response character of the low resistance static model is analysed, the static shift in some instance is corrected by using several static correction methods, their correction results are compared, and they all appears the better result. After static correction, a better quality data is achieved.

Key words: CSAMT; static effect; static model; static correction

3D VISUAL PRESENTATION OF INVERTED EM SOUNDING DATA ON MATLAB PLATFORM

LI Xiao-chang (Institute of Geophysical and Geochemical Exploration, CAGS, Langfang Hebei 065000, China). COMPUTING TECHNIQUES FOR GEOPHYSICAL AND GEOCHEMICAL EXPLORATION, 2007, 29 (suppl): 0068

3D visual presentation of 2D inverted data of controlled-source audiomagnetotelluric (CSAMT) sounding has been realized by using graphic user interface (GUI) on the MATLAB platform, so making the efficiency of data interpretation. increased.

Key words: MATLAB; 3D visualization; controlled-source audiomagnetotellurics sounding; diagram of inverted resistivity, the 3D show

PRELIMINARY INTERPRETATION OF MAGNETOTELLURIC SOUNDING IN THE COQÊN BASIN, CENTRAL TIBET

FANG Hui, HU Ping, ZHONG Qing, et al (Institute of Geophysical and Geochemical Exploration, CAGS, Langfang Hebei 065000, China). COMPUTING TECHNIQUES FOR GEOPHYSICAL AND GEOCHEMICAL EXPLORATION, 2007, 29 (suppl): 0072

As a part of the national project "Investigation and Evaluation of Strategic Prospect for Oil & Gas and Target Area Selection in Tibet Plateau", a magnetotelluric (MT) sounding was carried out in the Coqên basin. The preliminary interpretation for the boundary, basement depth and structural framework of the basin was made, and with a new idea of evaluating the prospect based separately on Mesozoic and Upper Paleozoic basins proposed. It was inferred that the southern boundary of Bangong Lake-Nujiang suture zone was a thrust fault stretching from north to south and might be underlaid by formations of Mesozoic. The interpretation above would be valuable for understanding the structural framework and oil & gas prospect of the Coqên basin.

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