

文章编号: 1001—1749(2011)03—0286—05

地震叠前偏移处理子系统集成技术

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摘 要: 设计开发通用处理模块集成框架,不仅适合偏移模块集成,也适合其它处理模块集成。做到每个处理模块的界面风格一致、操作方式一致、作业流程控制一致。集成界面的功能主要有作业卡的编辑修改、作业提交、删除作业、作业监控以及一些辅助功能。这里对处理模块参数进行了高度抽象,采用资源文件的方法,管理各个模块,通过模块注册,使模块的增加和修改变得异常简单,不必重复编写控制界面,非常便于系统的移植和维护。

关键词: 偏移系统; 资源文件; 模块注册; 作业控制; 集成界面

中图分类号: TP 31 **文献标识码:** A

0 前言

随着地震偏移方法的不断发展,iCluster 偏移成像系统规模不断扩大,目前,iCluster 系统中时间域偏移子系统和深度域偏移子系统涉及到的偏移方法(模块)很多,包括:叠前和叠后偏移,2D 和 3D,共二十多种偏移方法模块,加上预处理模块,近三十个处理模块。显然,不可能每个方法模块都做一个独立的控制界面,这样既烦琐,又不利于系统的维护和扩充,也不符合软件工程的要求。因此,必须对处理模块参数类型进行抽象,设计开发通用处理模块集成框架,适合所有处理模块,做到每个处理模块的界面风格一致,操作方式一致,作业流程控制一致。模块的增、删、改不需要修改源代码,特别是增加模块不需要重复编写控制界面,而是通过模块注册的方式完成模块加载,这不仅提高了软件开发效率,而且便于系统扩充。通用的模块集成框架不仅适用于偏移模块的集成,也适用于地震预处理模块的集成。

交互界面是软件与最终用户的接口,在很大程度上决定着软件的成败,开发工具的选择在软件开发过程中非常重要。近年来随着软件行业的蓬勃发展,跨平台软件开发已经成为一种发展趋势。Qt

是跨平台的 C++ 图形用户界面工具箱,具有国际化、面向对象和可用户化的外观等特点,Qt 使用“一次编写,随处编译”的方式,为开发 GUI 的用户提供了一个完整的 C++ 应用程序框架,并以其卓越的兼容性、高效的 C++ 性能和丰富的 API,成为 Unix/Linux 平台中 GUI 开发的事实标准。程序开发人员使用 Qt 的单一源程序,可以构建出能够独立运行于从 Windows 98 到 XP,从 Mac OSX、Solaris、HP2UX 到 Linux,以及其它基于 X11 库的 Unix/Linux 上的应用程序。因此,在 Linux 系统上开发交互界面程序,Qt 是较好的选择。

1 集成界面的功能设计

处理子系统的主控界面设计理念,是用一个主控界面,控制子系统的所有计算功能。设计的主控界面,必须满足计算过程所需的下列功能:

(1) 作业卡管理。每个模块的输入参数仍然采用作业卡的形式,作业卡的编辑、修改、输入和输出都在这个界面上完成。

(2) 并行作业节点选择,可供选择的节点列表,选择主节点名和进程数。

(3) 作业提交。运行方式有两种:①串行运行方式;②并行运行方式。作业提交可以用已经存

收稿日期: 2010-11-29

改回日期: 2011-04-21

在的作业卡 ,通过 “Browse”按钮读入 ,也可以是通过 “File/New”菜单生成新的作业卡。

(4) 断点恢复作业提交。

(5) 作业监控。通过作业监控 ,用户可以实时查询所有正在运行作业的基本信息 ,包括: 用户、工区、作业名、作业开始时间、主节点和所有计算节点等。

(6) 删除作业。当作业运行出错时 ,可以删除作业 ,用户只能删除该用户所属的作业 ,删除主节点作业等同于删除作业 ,所有计算节点作业一并删除。

(7) 可供选择的偏移模块列表。

(8) 其它辅助计算功能有数据整理(归约) 、数据格式转换和显示等。

其中 ,作业卡管理和作业控制是该子系统的核心功能。

2 处理模块参数抽象

所有批处理模块(不包括交互处理模块) 的输入参数都有一些共性 ,把这些共性进行归纳 ,得到新的参数类型。这里共归纳出了六大类型: ①文件类型(TYPE_FILE); ②字符型(TYPE_CHAR); ③整型(TYPE_INT); ④浮点型(TYPE_FLOAT); ⑤布尔型(TYPE_BOOL); ⑥ Qt 列表类(TYPE_LIST) ,这六种类型基本满足了处理模块的参数需要。每个处理模块的 I/O 参数必须按以上类型进行严格定义。以下是部份类型结构定义:

```
#define MaxNumOfChar 256
#define MaxNumOfNormal 20
#define MaxNumOfList 20
#define MaxNumOfModule 50
typedef struct{
    char filename [MaxNumOfChar ]; //文件名
    char filePath [MaxNumOfChar ]; //文件路径
    char suffix [MaxNumOfNormal ]; //文件后缀
    int io; //1 = 输入文件 2 = 输出文件
    int type; //数据类型标示
} TYPE_FILE;
typedef struct{
    char paraName [MaxNumOfNormal ];
    //参数名
    char marker [MaxNumOfChar ]; //参数说明
```

```
char sign [MaxNumOfNormal ]; //参数标示
int minValue; //最小值
int maxValue; //最大值
int defaultValue; //缺省值
} TYPE_INT;
typedef struct{
    char paraName [MaxNumOfNormal ];
    //参数名
    char marker [MaxNumOfChar ]; //参数说明
    char sign [MaxNumOfNormal ]; //参数标示
    float minValue; //最小值
    float maxValue; //最大值
    float defaultValue; //缺省值
} TYPE_FLOAT;
typedef struct{
    char paraName [MaxNumOfNormal ];
    //参数名
    char marker [MaxNumOfChar ]; //参数说明
    char sign [MaxNumOfNormal ]; //参数标示
    int type; //参数类型标示
    int number; //参数个数
    char currValue [MaxNumOfNormal ];
    //当前值
    char * value [MaxNumOfList ]; //列表值
} TYPE_LIST;
```

3 资源文件设计

处理子系统用资源文件管理子系统各个模块 ,控制模块的增、删、改。如果子系统中要添加、删除一个模块或者模块参数 ,只需要通过模块注册修改资源文件 ,不必重新编写界面程序 ,这既节约了人力 ,又提高了效率 ,同时也便于程序的维护。资源文件有两类 ,即子系统的资源文件和模块资源文件。

(1) 子系统资源文件定义子系统的属性 ,如子系统名、功能描述、模块个数、各个模块的执行程序名称等。

(2) 模块资源文件定义模块的属性和输入输出参数表 ,模块属性主要指模块功能、方法描述、参数个数、运行方式等 ,模块 I/O 参数表定义参数类型、取值范围、缺省值、参数描述等。

一个子系统只有一个资源文件 ,一个模块只有一个资源文件 ,二者是 “父子”关系。下面是子系统的资源文件和模块资源文件的结构定义:

```
typedef struct{
    char subSysName [MaxNumOfNormal ];
                                //子系统名
    char marker [MaxNumOfChar ];
                                //子系统功能说明
    int  number;                //模块个数
    MODULERES module [MaxNumOfModule ];
                                //模块资源文件
} SUBSYS;

typedef struct{
    char moduleName [MaxNumOfNormal ];
                                //模块名
    char marker [MaxNumOfChar ];
                                //模块功能说明
    char method [MaxNumOfChar ]; //方法简述
    char author [MaxNumOfNormal ]; //作者
    char date [MaxNumOfNormal ]; //日期
    char exeName [MaxNumOfNormal ];
                                //执行程序名
    int  number;                //参数个数
    bool bParallel;              //是否并行
    int  domain;                //时间域或者深度域
    int  dimension;              //2 = 2D 3 = 3D
    bool bPreStack;              //是否叠前处理
    .....    I/O 参数表
} MODULERES;
```

图 1 是资源文件管理流程图。

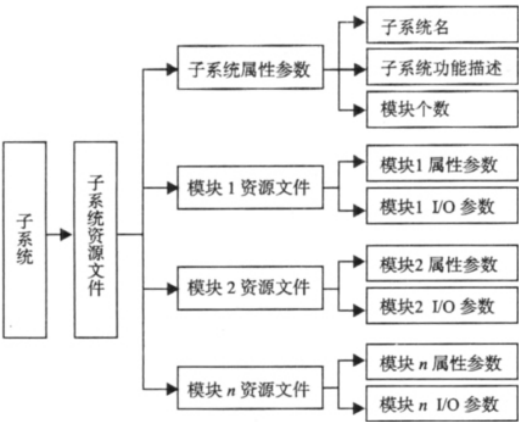


图 1 资源文件管理流程图

Fig. 1 The management workflow of resource file

4 模块注册

当用资源文件管理子系统及其模块时 ,添加模

块不需要编写界面或修改任何代码 ,通过模块注册的方式就可完成。模块注册工作仅由指定的系统管理员完成 ,对用户和非指定人员是不透明的。当需要增加模块时 ,由模块编写者填写模块属性表 (见表 1) 和参数表(见下页表 2) ,由系统管理员完成注册工作 ,更新资源文件。

图 2 是模块注册界面 ,界面左上部份是子系统列表 ,用于选择子系统;右上部份是模块属性表 ,填写模块属性;下方是模块 I/O 参数表。每个表下方都有一排控制按钮 ,从左到右 ,其功能分别是:鼠标移动到首记录、鼠标移到上一条记录、鼠标移到下一条记录、鼠标移动到最后记录、增加一行、删除一行、插入一行、确定、取消、刷新等。

表 1 模块属性表
Tab. 1 Module attributes table

名称	类型	说明
模块名	char*	
模块功能	char*	
方法简述	char*	
作者	char*	
日期	char*	
执行程序名	char*	
参数个数	int	
运行方式	int	1 = 串行 2 = 并行
叠前/叠后	int	1 = 叠前 2 = 叠后
时间/深度	int	1 = 深度 2 = 时间
2D/3D	int	2 = 2D 3 = 3D

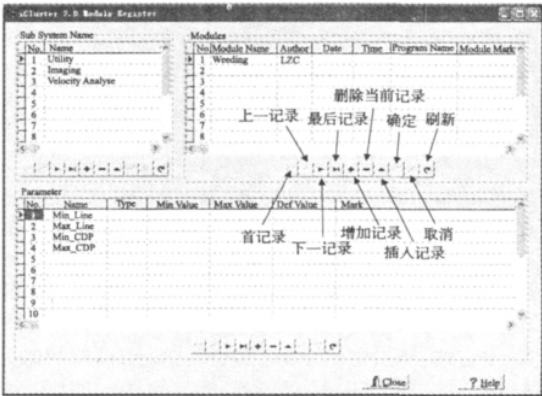


图 2 模块注册界面

Fig. 2 Module register interface

表 2 模块属性表
Tab.2 Module parameters table

模块名	abcd	参数个数	7	取值范围		
序号	参数名	类型	默认值	最小值	最大值	参数说明
1	InputSeisFile	char [*]	Seis. segy	none	none	输入地震数据文件
2	InputVelFile	char [*]	Vel. segy	none	none	输入速度数据文件
3	OutputFile	char [*]	Image. segy	none	none	输出文件
4	MinCDP	int	1	1	1000	最小 CDP
5	MaxCDP	int	1000	1	1000	最大 CDP
6	MinLine	int	1	1	800	最小线号
7	MaxLine	int	800	1	800	最大线号

5 集成界面的开发

5.1 开发环境

模块集成界面采用国际上流行的 Qt4 开发完成。Qt 这种图形界面工具包建立在 Xlib 基础上, Qt 基于 C++ ,速度快 ,易于使用 ,具有很好的可移植性 ,不使用任何本地工具包调用 ,这在很大程度上提高程序的运行速度。另外 ,在 GUI 应用程序关心的用户交互问题上 ,Qt 部件采用不同于其它工具包的交互方式 ,通常 GUI 工具包使用回调函数来创建用户交互 ,但回调函数非常复杂 ,容易混淆 ,又难以理解。而在 Qt 编程中 ,只需要一行代码 ,便可以把用户事件和程序事件连接起来 ,这依赖于 Qt 特有的信号和槽二个功能。

(1) Qt 和 X11 的关系。Xlib 构建了编写 Xwindow 程序的最底层功能 ,Qt 则基于 Xlib 之上建立了更高层次的工具包 ,使用 Qt 编程比直接使用 Xlib 编程效率更高。

(2) Qt 和 Motif 的关系。Qt 是基于 Xlib 的工具包 ,Motif 则是基于 Xt 的工具包 ,而 Xt 又是基于 Xlib 之上的工具包。因此 ,二者建立的底层基础是相同的(见图 3)。

5.2 偏移处理子系统主控界面简介

图 4 是采用 Qt4.1 开发的 iCluster2.0 版时间偏移处理子系统主控界面 ,窗口左边是时间偏移模块列表 ,用鼠标点击某一模块时 ,右上方表中列出了该模块的输入文件及路径 ,通过双击弹出文件选择对话框 ,输入文件;窗口右中间的表是自动拼接的输出文件列表;窗口右下方是模块的输入参数 ,

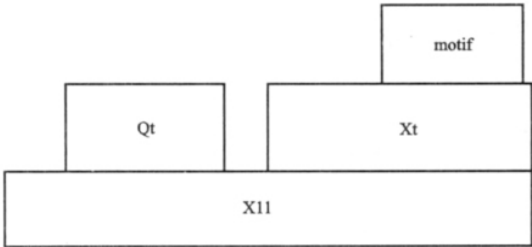


图 3 Qt 和 Motif 与 X11 的关系
Fig.3 The relationship between Qt and Motif X11

每个参数都有参数说明和缺省值 ,参数编辑方式同 Excel 电子表格 ,易于掌握。工具栏从左到右依次是打开 ,保存作业卡 ,提交、删除作业和作业日志文件浏览。

图 5 是“File”菜单 ,其主要功能是对作业卡的存取操作。

图 6(见下页)是“Application”菜单 ,该菜单包含了偏移子系统的主要功能 ,如:作业提交、作业浏览、作业管理、作业删除、数据转换及显示等等。

图 7(见下页)是偏移作业的处理流程。



图 4 时间偏移子系统主控界面
Fig.4 The control interface of PSTM subsystem

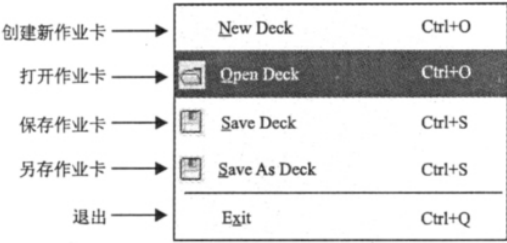


图5 “File”菜单及功能

Fig. 5 The function of File menu



图6 “Application”菜单及功能

Fig. 6 The function of Application menu

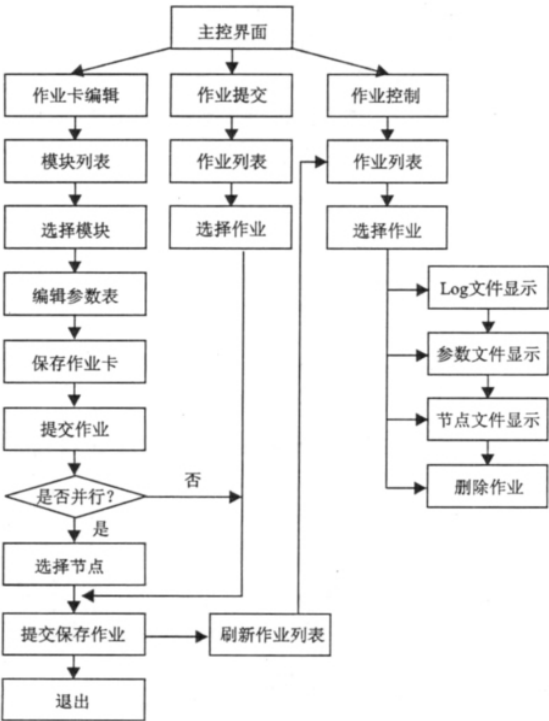


图7 偏移作业处理流程图

Fig. 7 The workflow of migration job

6 结束语

在 iCluster 系统 2.0 版本偏移子系统的开发中,我们提出了一种基于资源文件的模块管理方法和模块注册的概念,非常有利于子系统的扩充。模块及模块参数的增、删、改,不必修改源代码,增加一个处理模块,不必编写控制界面,通过模块注册完成,达到既省时又省力的目的,同时也便于系统的维护和扩充。采用跨平台 Qt 4.1 开发环境,开发处理模块集成框架,增强了软件的可移植性,该框架不仅适合偏移模块的集成,也适合其它预处理模块的集成。目前,iCluster 偏移系统已应用于实际资料的处理中。

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ting seismic profile properties. To solve this problem, we calculate the amplitude spectrum and phase spectrum of seismic wavelet dynamically in post-stack migration seismic section, and then synthesize wavelet of any phase type. By using dynamic wavelet extract the absorption coefficient profile, the differences of reservoir with and without oil and gas can be finely showed in significant, combining with the analysis of the dynamic absorb coefficient map of No. 1 Jia section, which provides a accurate method for detailed interpretation of the reservoir in work area.

Key words: dynamic wavelet; wavelet extraction; absorption coefficient; wavelet estimation

APPLICATION OF MULTI-ANGLES ELASTIC IMPEDANCE INVERSION IN FENCHENG AREA OF JUNGGAR BASIN

ZHU Ming, LOU Wei, FAN Xu, et al. (Research Institute of Exploration and Development, Xinjiang Oilfield Company, Urumqi Xinjiang 830011, China). *COMPUTING TECHNIQUES FOR GEOPHYSICAL AND GEOCHEMICAL EXPLORATION*, 2011, 33(3): 268

Lithology is complicated in the Fencheng formation of Permian, Fencheng area, northwestern margin of Junggar basin. There are three major category of lithology of sedimentary rocks, dolomite and volcanic rocks, so reservoir prediction is difficult, which restricted exploration in the area. The research presented in this paper used multi-angle elastic impedance inversion method, carried out the well logging data analysis and interpretation based on consideration of rock physics modeling for the objective formation by selecting the appropriate rock physics model to forecasts shear velocity for all well in the region, optimizing elastic modulus and establishing plates of lithologic hydrocarbon and elastic parameters. By setting up the structural model with thrust fault for the inversion of the initial model and testing parameters of inversion several times, the reservoir forecasting is completed in the objective region. Actual results analysis shows that the multi-angle elastic inversion results has good agreement with drilled wells, and the new oil and gas areas are presdicted. The technology is proved effective in the area.

Key words: Junggar basin; fencheng area; fencheng formation; dolomites; multi-angles elastic impedance inversion; rock physic model

ANALYSIS OF INFLUENCE FACTORS FOR AVO RESPONSE CHARACTERISTICS OF P-SV WAVE

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AVO technology is an effective method in predicting and deciding the fluid properties and lithology of the reservoir. To make the response characteristics clearer and the inversion of AVO analysis and lithologic parameter easier, according to the approximate valuation of reflection coefficient on P-SV wave, the paper carried out quantitative calculation on four theoretical models respectively, and precise comparative analysis with the exact solution of Zoeppritz equation. At last, four AVO models were used in forward modeling of P-SV and the fundamental factors on affecting the response characterizes of converted wave AVO were analyzing in detail which is significant to the improvement of precision and the reduction of interpretation ambiguity on AVO inversion based on AVO.

Key words: P-SV wave; energy distribution; reflection coefficient; AVO forward modeling

GENERALIZED S-TRANSFORM AND ITS APPLICATION TO REMOVE SURFACE WAVE

DUAN Jun, ZHANG Bai-lin, PAN Shu-lin (College of Resource and Environment, Southwest Petroleum University, Chengdu Sichuan 610500, China). *COMPUTING TECHNIQUES FOR GEOPHYSICAL AND GEOCHEMICAL EXPLORATION*, 2011, 33(3): 280

Surface wave is the main factor that affects signal to noise ratio and resolution in pre-stack seismic data. The traditional methods of suppression of the surface wave have some unavoidable defects. Generalized S-transform can transform the single-channel seismic records from the time domain to the time-frequency domain, make the surface wave and effective wave separated clearly in the time-frequency domain, cut the surface wave in the time-frequency domain then inverse transform back to the time domain we can remove the surface wave. Removing the surface wave via the generalized S-transform in the pre-stack seismic data is proposed in this paper, the theoretical models and real data results show that this method can remove surface wave while the effective wave also has very good protection, signal to noise ratio and resolution of the data have been greatly improved and avoid spatial aliasing.

Key words: generalized S-transform; pre-stack denoising; time-frequency analysis; seismic data processing

TECHNIQUE OF ICLUSTER MIGRATION SUBSYSTEM INTEGRATION

ZHOU Wei, LIU Zhi-cheng, FANG Wu-bao, et al. (Sinopec Geophysical Research Institute, Nanjing 210014, China). *COMPUTING TECHNIQUES FOR GEOPHYSICAL AND GEOCHEMICAL EXPLORATION*, 2011, 33(3): 286

Along with the unceasing emergence of new technologies and new methods, the iCluster system needs to be renewed constantly. The new version of iCluster migration processing module using Qt programming technology, whose class library is cross-platform object-oriented C++ class library. The traditional Mo-

tif programming is extremely basic and tedious, while Qt has the characteristics of highly object-oriented and modularization which make the developers easier and programming efficiency higher. Design and development of common processing module integration framework is not only suitable for the migration module integration, but also for others. So the processing module interface style, the operation and the workflow control should be consistent. The main function of the integrated interface includes job deck editing, job submission, job deletion, job monitoring and some auxiliary functions. After we abstract processing module parameters highly, the module additions and modifications become very simple by using the resource file approach and module registration. We do not need to compile the control interface repeatedly, so the system's transplant and the maintenance are very convenient.

Key words: migration system; resource file; job manage; integration interface; modul register

NATURAL NEIGHBOUR INTERPOLATION AND ITS APPLICATION TO 2D GRID OF IRREGULAR DATA

ZHANG Wei, QIN Qing-yan, JIAN Xing-xiang (College of Information and Engineering, Chengdu University of Technology, Chengdu 610059, China). *COMPUTING TECHNIQUES FOR GEOPHYSICAL AND GEOCHEMICAL EXPLORATION*, 2011, 33(3): 291

As the observation data is insufficient, two-dimensional interpolation of irregular discrete data is widely used in geophysics. In this paper, we researched and implemented a two-dimensional interpolation of Natural Neighbour algorithm, which will be applied to the MT 2D inversion real-time imaging. Example results show that the method has high accuracy, effective, fast and easy simulation of the data with terrain.

Key words: natural neighbours; 2D interpolation; data gridding

RESEARCH AND IMPLEMENTATION OF GIS-BASED LONG-PERIOD MAGNETOTELLURIC VISUALIZATION DATA MANAGEMENT PLATFORM

QIN Qing-yan, ZHANG Wei, WANG Xi-chong (College of information Engineering, Chengdu University of Technology, Chengdu 610059, China). *COMPUTING TECHNIQUES FOR GEOPHYSICAL AND GEOCHEMICAL EXPLORATION*, 2011, 33(3): 296

The paper proposes a method which applies database and GIS technology on the visual management of LMT data contrary to the shortcomings of traditional information management methods, which integrates survey sounding location with different spatial data sources such as administrative areas information, traffic information, digital elevation and tectonic information. The paper introduces the principle and process of the platform's implement, and also describes the

realization of survey points' plane projection and survey line's straight fitting. Application results show that the platform not only effectively manages data in simple and graphical ways, but also provides necessary information for the field production and data's qualitative processing and interpretation.

Key words: long-period MT; GIS; survey line projection; geological background

GUPTASARMA LINEAR FILTERING ALGORITHM IN CSAMT ONE-DIMENSIONAL FORWARD MODELING

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The basis of One dimension CSAMT forward problem is the Hankel transformation. Now the main solution to this problem is numerical filtering method, which runs the process of solving the given length of filter coefficients for additive operations. Therefore, the selected filter coefficients affect the precision and speed of the forward calculation. In this paper we use the Guptasarma linear filter coefficients and implement the algorithm. It's verified by the models that it fits well with the forward models with a relatively short length of filter coefficients, which makes a good basis of the next work in inversion or quasi two - dimensional problem.

Key words: CSAMT; one-dimensional forward calculation; fast hankel transformation; numerical filtering

DETERMINATION OF THE SPACE TREND FOR DEPTH ORE BODY BY THE ULTRA-HIGH DENSITY RESISTIVITY

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Ultra-high density resistivity method is a new geophysical method, the method is convenient, fast, effective, large data amount and so on. Because of the complex geologic structure and the surface topography, ore body space trend and connection is difficult to be determined. By using the well to well ultra-high density resistivity method, we have obtained the expectation result.

Key words: ultra-high density resistivity method; determination of depth ore body space trend; data excavate; repeat demonstrate; mine connection

EXPERIMENTAL STUDY ON THE IMPACTS OF ELECTRODE POSITION ON ANOMALY CURVES FOR CENTRAL GRADIENT ARRAY