

文章编号: 1001—1749(2011)01—0087—05

利用 3S 技术优化物探测地的方法研究

陈 亮, 庞庆恒, 崔志强
(中国地质科学院 物化探研究所, 河北 廊坊 065000)

摘 要: 在物探工作设计阶段, 主要参考测区的地质图和地形图, 进行控制点的选取和测网的布置。但这些地形图往往是七十年代、八十年代绘制的, 随着自然环境的变化, 人类活动的改造, 可能发生了很大的变化, 如湖泊水位变化, 居民点变迁、城市的扩建、地质灾害等。随着“3S”集成技术的不断成熟, 可以利用带地理参数的遥感影像对地形图的变更部份进行修正, 充分利用 GIS 技术优化测区的控制网建设和物探工作部署, 进行科学、合理、准确的物探工作部署, 以达到提高物探工作的效率。

关键词: 3S 技术; 物探测地; 优化方法
中图分类号: P 208 **文献标识码:** A

0 前言

随着计算机技术的不断发展, 将遥感 (RS)、全球卫星定位系统 (GPS) 和地理信息系统 (GIS) 紧密结合起来的“3S”一体化技术, 已显示出更为广阔的应用前景。物探测地亦称物探工程测量, 它是应用大地、航测与工程测量等方法, 解决物探测量领域内的三维定位问题。在对新测区物探工作之初的工作设计阶段, 由于地质工作本身的特征所致, 要快速了解新测区的地质、地形情况, 往往非常困难。通常主要参考当地的地质图、地形图, 但这些地形、地质图往往是七十、八十年代所绘制的, 随着自然环境的变化, 人类活动的改造, 可能发生了很大的变化 (如湖泊水位变化, 居民点变迁、城市的扩建、地质灾害等)。利用最新的遥感图像、GIS 建模技术如 DEM 的建立, 模拟出测区的三位景观, 能够对 GPS 控制网建设和物探工作部署, 进行科学、合理的指导, 达到提高物探工作的效率。

1 利用 RS 技术更新地物信息

以内蒙某工区为例, 作者在收集到工区地形图

后, 通过搜集当地最新的遥感影像与测区地形图, 经过对比发现, 所收集的地形图年代较老, 与实际情况存在很大差异, 利用遥感影像上的特征点对其地理参数进行校正, 使其具有相同的坐标系统和投影参数, 对二者进行套合。

1.1 坐标系转换

要利用遥感影像对地形图进行校正, 首先要统一二者的坐标系统。作者获取的是 ETM-741 波段合成的假彩色遥感影像, 采用莫卡托投影和 WGS-84 坐标系统, 而地形图采用的是北京 54 椭球参数和高斯克吕格投影。在知道了二者的坐标系和椭球参数以及转换参数 (可以从当地测绘局获取或者利用工区附近的至少三个已知控制点求取) 后, 再对它们进行相互转换、套合 (如下页图 1 所示)。

1.2 更新地形图

在统一遥感影像和地形图的坐标系统后, 利用 MAPGIS 图形处理功能对地形图进行校正。通过上述处理后的地形图 (见下页图 2), 发现了测区南部水库的水位, 居民点等地形图在测绘时发生了很大的变化:

(1) 现在的水位明显比地形图所显示的低了很多, 新增面积为 1.5 km^2 。

(2)新增居民地三个, 面积为 0.6 km²。

如果物探工作依据所收集的地形图布置工作, 显然就会出现较大的偏差。

利用 GIS 技术对地形图上的地物信息进行更新后的地形图, 在进行后期工作的设计时能够更加准确。这里要说明的是物探测网的设计也是利用 GIS 技术进行的, 专业人员根据项目的任务书, 明确测网的网度、方位、范围等要求后, 根据测区的地质、地形地貌情况, 利用 MAPGIS 合理的布置每个测点, 对设计工作量进行精确的统计, 通过带地理信息的遥感图像对地物信息进行更新后, 能够减少工程实施阶段的不可预知性, 所设计的物探测网与实地情况吻合程度更好, 使预算更合理。

2 GIS建立 DEM 模型及其应用

2.1 数字高程模型概念

数字高程模型 (Digital Elevation Model 缩写 DEM) 是一定范围内规则格网点的平面坐标 (X, Y) 及其高程 (Z) 的数据集, 它主要用于描述区域地貌

形态的空间分布, 是通过等高线或相似立体模型进行数据采集 (包括采样和量测), 然后进行数据内插而形成的。DEM 是对地貌形态的虚拟表示, 可派生出等高线、坡度图等信息, 用于与地形相关的分析应用。

2.2 建立 DEM 模型

建立 DEM 的方法有多种。作者从现有地形图上, 用扫描仪半自动采集后, 利用 GIS 软件矢量化。在等高线和高程点, 建立不规则三角网 (Triangular Irregular Network, 简称 TIN)。然后在 TIN 基础上, 通过线性和双线性内插建立 DEM。利用 GIS 建立 DEM 可视化三维模型 (如图 3 所示)。

2.3 DEM 模型的应用

- DEM 模型的应用主要有以下三个方面:
- (1)物探测网的布设, 测线往往要垂直于地质体的走向。DEM 三维模型, 有利于测网设计人员更直观的认识地质体的走向。
 - (2)利用 GIS 软件, 对 DEM 模型进行图切剖面 (见图 4), 可以根据图切剖面选取利于野外工作的测网路线, 避开测线垂直切割悬崖、跌水等难以

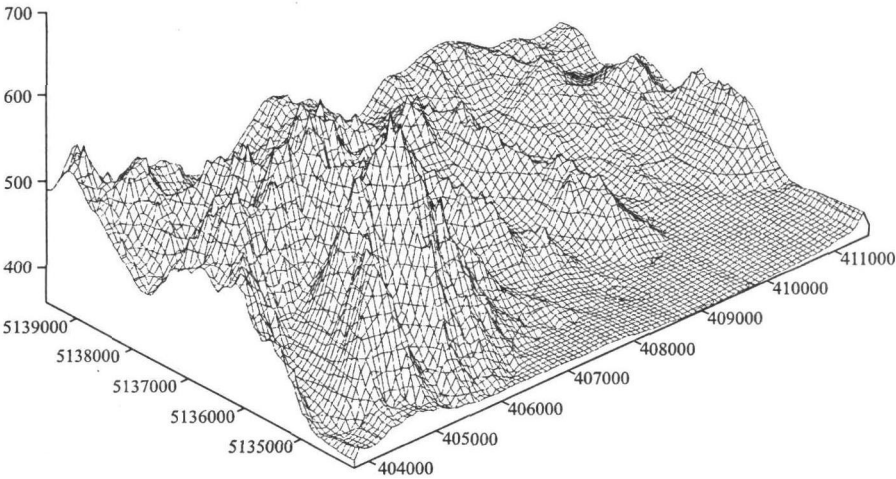


图 3 DEM 模型
Fig 3 DEM model

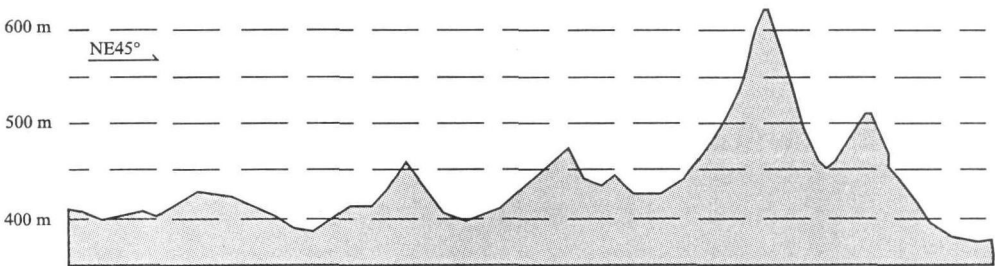


图 4 DEM 模型地形剖面

Fig 4 Topography profile under DEM model

通过地区,降低野外工作的难度。

(3)DEM 模型能更加直观地反应工区内海拔高程的分布,进行水淹分析,可以优选工区内的至高点,有利于对控制测网布置进行总体把握。

3 物探测地 GPS- RTK 工作方法

3 1 RTK 工作原理

实时载波相位差分简称 RTK,二台接收机(一台基准站,一台流动站)都在观测卫星数据。同时,基准站通过其发射电台,把所接收的载波相位信号(或载波相位差分改正信号)发射出去。那么,流动站在接收卫星信号的同时,也通过其接收电台接收基准站的电台信号。在这二信号的作用下,流动站上的固化软件就可以实现差分计算,从而精确地确定基准站与流动站的空间相对位置关系。

3 2 物探测网的实施

基于 RTK 工作原理,只要保证基准站和流动站保持数据链的畅通,在工作时,基准站可以架设在未知点上,这就为控制网的布设降低了难度。我们现在可以选取少量控制点建立在交通便利,视野开阔的地方,这就大大节省了人力物力,也简化了

后期的 RTK 放样工作。

作者利用 RS 解译出来的信息,把物探放样工作分为二个区域:

- (1)西区无植被覆盖,主要为农地,地形平坦。
- (2)东区地形起伏较大,有植被覆盖,放样工作难度较大。

由于工区面积较小,共建立了四个点的 E 级控制网。

作者在东区选择三个点,在西区选择一个点作为测区的控制点,并建立了控制网(如图 5 所示)。

采用南方的 S80 双频接收机,进行静态控制测量后,与国家控制网联测,最后解算出各控制点坐标(见表 1)。

表 1 控制点坐标
Tab 1 Control point coordinates

控制点	坐标 横坐标 X (m)	纵坐标 Y(m)	高程 H (m)
K z001	408394. 44	5139286. 08	421. 22
K z002	405418. 82	5138794. 88	450. 20
K z003	406731. 92	5134723. 45	430. 11
K z004	411285. 02	5125951. 50	380. 23

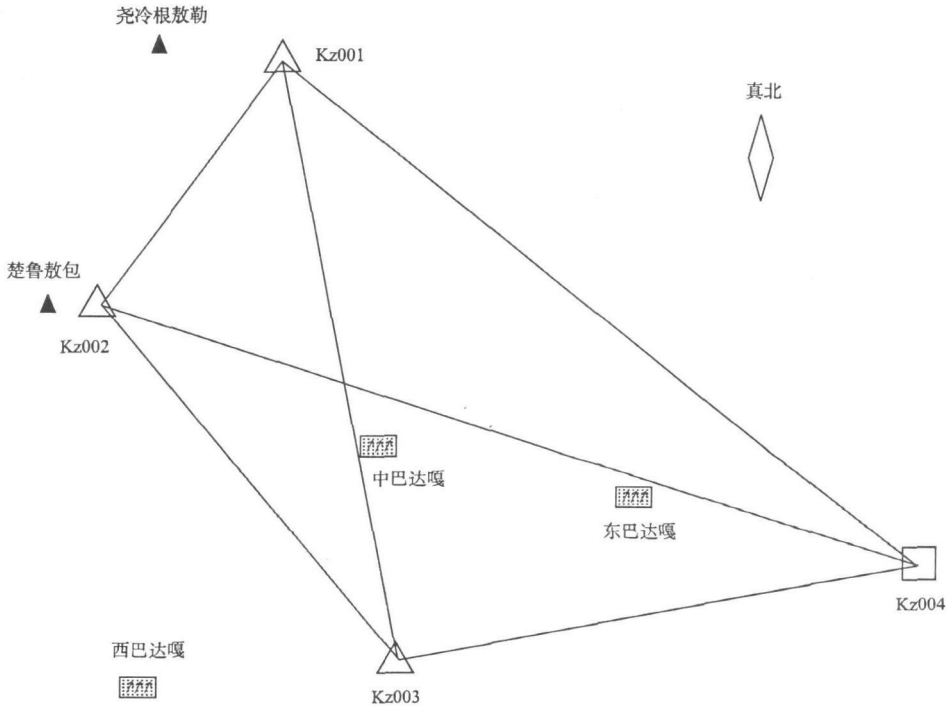


图 5 工区控制网

Fig 5 A rea control network

基于 3S 技术的优越性, 合理的控制布网可以使在后期的测网放样工作能顺利有序的进行, 整个物探测地工作可以在很短的时间内, 就可高质量的顺利结束。

4 结论

作者在本文中分别阐述了 RS 修正地物信息, GIS 建立 DEM 及其应用, 物探测地 GPS-RTK 工作法。在整个物探测地的工作中, 3S 技术相互关联组合, 优化了物探测网的实施, 解决了在物化探工程测量中遇到的一些实际问题, 提高了快速勘查的可靠性和准确度。随着 3S 技术的不断成熟和发展, 相信 3S 在资源勘查中有更广阔的应用空间。

参考文献:

- [1] 余鹏, 刘丽芬. 利用地形图生产 DEM 数据的研究 [J]. 测绘通报, 1998 (10): 16
- [2] DZ/T 0153—9. 中华人民共和国地质矿产部行业标准. 物化探工程测量规范 [S]. 北京: 中国标准出版社, 1994
- [3] 徐绍铨, 张华海, 杨志强, 等. GPS 测量原理及应用 [M]. 武汉: 武汉大学出版社, 2001.
- [4] 李卫正, 艾畅, 彭世揆, 等. 一种利用地形图和遥感影像提取小班界线的方法 [J]. 林业大学学报, 2009, 33 (2): 69.
- [5] 石淑芹, 陈佑启, 姚艳敏, 等. 基于 3S 技术的区域性耕地资源变化影响评价模式研究 [J]. 农业工程学报, 2008, 24(7): 69
- [6] 郭庆胜, 杨族桥, 冯科. 基于等高线提取地形特征线的研究 [J]. 武汉大学学报 (信息科学版), 2008, 33 (3): 253
- [7] KOENDERINK J J, DOORMAN A J V. Local features of

smooth shapes, ridges and courses [C]. Geometric Methods in Computer Vision II. SPIE, San Diego, CA, USA, 1993

- [8] 余坤勇, 林芳, 刘健. 基于 RS 的闽江流域马尾松林分蓄积量估测模型研究 [J]. 福建林业科技, 2006, 33 (1): 16
- [9] 王茜, 薛怀平, 吴胜军, 等. 利用地形图批量生产 DEM 数据的方法 [J]. 上海师范大学学报, 1998, 32 (2): 83
- [10] 杨燕琼, 吴奔敏, 黄平. 基于 RS GIS 的林分蓄积量估测 [J]. 华南农业大学学报 (自然科学版), 2003, 24 (3): 73
- [11] 苏丹阳, 富强, 楼章华, 等. 基于三角网 DEM 的地形特征提取算法 [J]. 应用基础与工程科学学报, 2009, 17(增刊): 37.
- [12] 刘学军, 卢华兴, 卞璐. 基于 DEM 的河网提取算法的比较 [J]. 水利学报, 2006, 37 (9): 1134
- [13] 刘学军, 王永君, 龚健雅. DEM 流域网络提取算法的误差特性分析 [J]. 测绘学报, 2007, 36 (2): 224
- [14] MAYORGA E, LOGSDON M G, BALLESTER M V R, et al. Estimating cell-to-cell land surface drainage paths from digital channel networks with an application to the Amazon basin [J]. Journal of Hydrology, 2005, 315 (124): 167.
- [15] 胡良军, 李锐, 杨勤科. 基于 GIS 的区域水土流失评价模型 [J]. 应用基础与工程科学学报, 2000, 8 (1): 1.
- [16] 谢顺平, 都金康, 王腊春. 利用 DEM 提取流域水系时洼地与平地的处理方法 [J]. 水科学进展, 2005, 16 (4): 535.

作者简介: 陈亮 (1985—), 男, 四川广安人, 助理工程师, 现主要从事地质矿产物探解释方法技术研究。

state of fractures and could be used to analyze the extent of opening, connectedness, and the crashing extent of fractures. It can be made use of in exploration of groundwater and describing of the fractures character. Combining with the geological data, it could accurately be the base of exploration of groundwater resource. Here, for the aim of groundwater-rich zones, radon-detection was applied in exploration of fracture groundwater resource in Qingyuan mountain in Quanzhou, east-southern China. And the results shown that there was two obvious faults named F1 and F2 with the direction of North-West West and North-West in Qingyuan mountain. Combining with the geological data, F1 fault was engendered from orogeny and F2 fault was original from invading of granitoids and tectonic activity, they were an ideal reserving space of groundwater. And the extending of the faults was 2.5 km ~ 3.0 km, water catchment area was more than 13 km² with $211 \times 10^4 \text{ m}^3/\text{a}$ of precipitation recharge, the storage of fracture groundwater was about $5.1 \times 10^8 \text{ m}^3$.

Key words radon-detection, radon anomaly, groundwater

THE NEW AIRPORT SITE TESTING METHODS AND ENGINEERING GEOLOGY ANALYSIS BASED ON REMOTE SENSING AND GIS TECHNOLOGY

LITian-hua¹, YANG Wu-nian² (1. Prospect and Design Institute of Chengdu Military Air Force, Chengdu 610041, China; 2. Institute of RS and GIS, Chengdu University of Technology, Chengdu 610059, China). *COMPUTING TECHNIQUES FOR GEOPHYSICAL AND GEOCHEMICAL EXPLORATION*, 2011, 33 (1): 79

In this paper, "3S" technologies (RS, GIS, GPS) are applied to the airport geological survey based on modern remote sensing technique. The up-to-date remote sensing image as LANDSAT, ETM image (spatial resolution 15m), SPOT image (spatial resolution 2.5m) and QUICKBIRD image (spatial resolution 0.61m), etc were taken as the information source, and through the digital processing such as remote sensing image data fusion, the numerical mosaics, image enhancement. The ortho-image map of different types, different bands and different resolutions are produced and the best images for airport Engineering Geology reconnaissance can be produced. Based on the remote sensing image enhancement processing, information extraction and GIS spatial analysis, we can interpret the geological structure and geological disaster with the tools of GPS. The method can be applied

in the field such as to do geological construction trait analysis, the analysis of distribution of hidden rupture and active rupture, furthermore the hydrogeological phenomena analysis as Karst funnel and hill-slope. The data it got above can be taken as the foundation for the project geological survey of XIAOSHAN airport.

Key words "3S" technologies, geological survey, airport selection, orthoimage

MODELING METHODS OF DIGITAL ELEVATION MODEL FOR WATERWAY

ZENG Tao¹, YANG Wu-nian¹, LU Xi-ming², et al (1. Institute of RS and GIS, Chengdu University of Technology, Chengdu 610059, China; 2. Guangzhou Zhengfangyuan Engineering Consulting Co., Ltd, Guangzhou, 510023, China). *COMPUTING TECHNIQUES FOR GEOPHYSICAL AND GEOCHEMICAL EXPLORATION*, 2011, 33(1): 83

Based on the underwater terrain survey raw data obtained by GPS-RTK and depth sounder, the authors constructed a channels digital elevation model in Dongguan city by VC+ ObjectARX CAD redevelopment and discussed the precision and efficiency of Several ways in Grid DEM construction. We conclude that the linear interpolation based on TIN is the high-efficiency and high-precision approach of constructing underwater Grid DEM, especially in the undulating terrain.

Key words digital waterway, underwater topographic survey, objectARX CAD+VC, DEM interpolation

THE STUDY ON THE "3S" TECHNOLOGIES TO OPTIMIZE GEOPHYSICAL MEASUREMENTS

CHEN Liang, PANG Qing-heng, CUI Zhong-qiang (Institute of Geophysical and Geochemical Exploration, CAGS, Langfang Hebei 065000, China). *COMPUTING TECHNIQUES FOR GEOPHYSICAL AND GEOCHEMICAL EXPLORATION*, 2011, 33(1): 87

In the design phase of geophysical measurement, the main reference points selection and network arrangement is mainly based on the map of cartography. But these topographic maps were drawn from the 1970s and 1980s, and they may have changed a bit, such as the water level of a lake, the expansion of urban residential change, the geological hazards, etc with the natural environment changes and human activities. With "3S" integration technologies getting to mature, the remote sensing image of geographical parameters can be used for correction of the map, and fully using the GIS technology optimize control net-

work construction and test of geophysical work deployment. So scientific and reasonable, accurate exploration work can be carried out to improve geophysical efficiency.

Key words "3S" technology location survey of geophysical measurements optimizing method

GRAVITY NEAR ZONE TERRAIN CORRECTION PRECISION DISCUSSION

YANG Ya-bin, HAN Ge-ming, LIANG Meng (Institute of Geophysics and Geochemical Exploration, Langfang 065000, China). *COMPUTING TECHNIQUES FOR GEOPHYSICAL AND GEOCHEMICAL EXPLORATION*, 2011, 33(1): 92

Working in Large-scale gravity exploration, the influence of short range terrain correction and intermediate area topographic correction error on gravity precision is great. In reality, short range terrain correction is calculated on actual measurement or using reliefmap, and intermediate area topographic is calculated on using reliefmap. "The standard for large-scale gravity survey" only consider the influence of terrain elevation precision on gravity precision, but ignores the influence of reliefmap precision. On the basis of formula of terrain correction, we discuss the influence of scale, elevation and plane precision on gravity precision. We put forward some suggestions on the demand on scale, elevation and plane precision basis on terrain correction precision.

Key words terrain correction, elevation precision, plane precision, scale

THE INTEGRATION OF THREE DIMENSION GEOLOGICAL MODELING AND GEOGRAPHIC INFORMATION SYSTEM

LI Fang-yu (State Key Laboratory of Petroleum Resources and Prospecting, China University of Petroleum, Beijing 102249, China). *COMPUTING TECHNIQUES FOR GEOPHYSICAL AND GEOCHEMICAL EXPLORATION*, 2011, 33(1): 97

The application objectives of 3D GIS and GIS are different, so their research focuses are different. Their integration can promote their development, but the systemic research on their integration is little. The paper compares and analyses their function and indicates the significance of the integration. Then the paper propose the ways of the integration and analyses their merits. At last, the paper forecasts the development trends of their integration.

Key words 3D GIS, 3D geological modeling, integration

RESEARCH ON THE INVERSION ALGORITHMS OF THE β IN THE PURE SHEAR MODEL

ZHANG Jing¹, SONG Ha-bin² (1. The Geological Exploration Institute of Liaoning Metallurgical Geology Bureau, Anshan 114038, China; 2. Key Laboratory of Petroleum Resources Research, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing 100029, China). *COMPUTING TECHNIQUES FOR GEOPHYSICAL AND GEOCHEMICAL EXPLORATION*, 2011, 33(1): 101

The previous algorithms of stretching factor inversion are based on single-well data fitting the calibration, and has almost researched the incorporation of structure and thermal evolution. This article uses the pure shear model formula of calculating subsidence and heat flow, which McKenzie put forward in the 1978. Based on the idea of one-dimensional inversion stretch factors, this paper uses the GUI function of Matlab software compiling the interface of the multipoint inversion of stretching factors, and reduces the workload which makes the false well data in the inversion of stretching factors. As the example of the survey line of SO49-25 in north-central area of the south China sea, this paper calculates the stretch factors and paleo-heat flow and verifies the feasibility of the algorithm.

Key words pure shear model, stretching factor, inversion

GOOGLE EARTH-BASED NUCLEAR DATA PROCESSING WITH E-LANGUAGE

LI Fei, GE Liang-quan, MA Ying-jie (Chengdu University of Technology, Chengdu, Sichuan 610059, China). *COMPUTING TECHNIQUES FOR GEOPHYSICAL AND GEOCHEMICAL EXPLORATION*, 2011, 33(1): 107

The direction of this study is to use integrated module of E-language to edit to achieve the processing and display of mass nuclear exploration point information in the Google Earth platform, that is to use the powerful visualization google Earth platform and the intuition of KML module, the entire programming is completed by E-language. The nuclear survey data can be directly read and changed and invokes the KML module integrated in E-language environment, then be written as KML data format identified by Google Earth. Different modules can be used to achieve different functions according to actual situations, this powerful Google Earth platform will open a new chapter for the nuclear investigation.

Key words Google Earth, KML, E-language