

GPS 与传统测量技术在地质勘查中应用比较

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摘要: 结合大型工程实例, 通过控制测量、地形测量、地质勘探工程测量对传统测量技术与 GPS 测量技术进行了比较分析, 结果表明, GPS 测量技术具有作业速度快、成果质量高等传统测量技术无法比拟的优越性。

关键词: GPS; 传统测量; 地质勘探工程测量;

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为满足地质勘查和矿山开采设计等工作, 需要对勘探区进行控制测量、地形测量、勘探网测量、勘探线剖面测量、勘探坑道测量、钻孔及地质点的定位测量、矿区勘界测量。所谓的传统的测量技术是采用经纬仪、水准仪、大平板仪、测距仪、全站仪等测量仪器进行测绘工作, 大部分测量队伍一台经纬仪(到上世纪 90 年代为全站仪)打天下, 直至 GPS 特别是 GPS RTK 在测绘工作中的广泛应用, 给测绘的野外工作带来了质的飞跃。本文就 GPS 与传统测量技术在地质勘查工程测量中应用情况进行探讨分析。

1 控制测量

传统的矿区控制测量一般都是在国家等级控制点的基础上, 采用测角网、测边网、边角网、导线网、线型锁、测角(测边)交会等手段进行。采用上述传统的测量手段, 点的位置必须满足必要的通视条件, 观测受时间、气象条件的限制比较多。有些点位为满足通视需要花大量的资金建造较高的觐标或者砍伐大量的树木。因此用传统的测量方法建立控制网有耗时长、费用高、精度低等弊端。

由于 GPS 定位技术具有高精度、全天候、测站间无需保持通视等优点, 因而已基本取代传统方法为建立各级平面控制网的主要手段。国内外资料表明, 利用 GPS 来布设国家控制网、城市控制网、工程测量控制网时, 所需的工天数大约为常规方法的 1/6, 所需费用在国外为常规方法的 1/6, 在国内为常规方法的 1/3 (主要是由于国内的劳动力相对较为廉价), 而且精度也比常规方法好, 因而得到了广泛地应用^[1]。

GPS 在高程控制网的建立方面也有突出的优势。一般情况下, 平地、低丘地区面积在 100 km 以内的测区, 联测 4-5 个高精度的已知高程点; 面积在 100 km 以上

的测区, 联测 6-10 个高精度的已知高程点, 就可以通过高程拟合的方法取得所有控制点的高程, 只要已知高等水准点分布均匀, 必要时再进行精化水准面, GPS 拟合高程也能够达到相应等级的水准高程的精度^[2]。

我单位在非洲某国的 3 个地质勘探项目中, 在 3 个旱季(该国每年 12 月至来年的 5 月为旱季, 6 月至 12 月为雨季)完成 2 000 多 km² 的三等 GPS 控制测量, 计 40 点; 完成四等 GPS 控制测量 570 km², 计 115 点, (GBT 18341-2001《地质矿产勘查测量规范》中的 GPS 控制测量按三等、四等、一级、二级等分级)总计投入 12 台 GPS 接收机, 耗时 50 d (包括三四等 GPS 高程控制测量), 快速、高质量建立起来的控制网, 为后续的地质勘探网的布设、地形测量、地质工程测量等工作的开展提供了可靠的控制依据, 使勘探项目部的所有设备和人员全部得以高速运转, 为全面完成合同约定的工程项目打下了坚实的基础。

2 地形测量

地质矿产勘探区大比例尺地形图是进行地质勘探和矿山规划设计所必需的基础图件资料, 地质勘探和规划设计能否科学顺利地进行取决于能否快速准确地获得高质量的现势地形图。用传统的方法测图, 需要先建立控制网, 在控制网基础上加密控制点, 再利用加密的控制点布设图根点, 最后在图根点上安置仪器进行碎部测量, 绘制成大比例尺地形图。所需仪器多为经纬仪、大平板仪、绘图板、塔尺等, 到后来用于野外数字化采集的全站仪、棱镜等设备, 使用这些设备都摆脱不了对高密度控制点(规范规定每平方公里内 1:1 000 比例尺测图不少于 45 点, 1:2 000 比例尺不少于 14 点, 1:5 000 比例尺不少于 5 点, 并应均匀控制测区。当利用全站仪进行数字测图时, 图根点的

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数量可较上述规定减少 1/2) 的依赖,劳动强度大、速度慢、精度低、耗时长,每组至少需要 2-3 个人。采用 GPS RTK 测量技术,不需要进行加密控制,在首级控制网建好后即可进行碎部测量,基准站可以设置在已知控制点或者设置在接收卫星信号和无线电信号条件好的未知点上,流动站经已知点进行校准和检查平面坐标和高程满足限差要求时就可进行数据采集作业。一个基站可以支持多个流动站进行作业,一个流动站只需要 1 个人就可以操作,在沿线碎部点上只需停留几秒钟,就可以获得每点平面坐标、高程(固定解)。结合输入的点特征编码及属性信息,构成碎部点的数据库,通过 CASS 软件自动绘制稍加人工修改即可绘成高精度地形图^[3]。一个基准站的辐射半径可达 3 km-5 km,因此不需要加密图根控制,控制点之间也不需要通视。所以采用 GPS RTK 技术进行全野外数字化地形测量的优势明显,劳动强度小、速度快、精度高、耗时短,得到测绘同行的认可。

我单位在非洲某国的 3 个地质勘探项目中,采用 GPS RTK 技术,投入 20 台套 GPS RTK 接收机,在总计约 120 d 左右的时间内,完成 1 5000 全野外数字化地形测量 570 km²,为地质勘查工作提供了及时可靠的用图保障,创造了在非洲地质勘探工作的奇迹,速度之快、质量之高受到该国地矿部和甲方的好评。如果采用传统的测图技术,在这么短的时间内是无法完成这么大的测图任务。

3 地质勘探工程测量

常规的地质勘探测量包括勘探网测量、勘探线剖面测量、勘探坑道测量、定位测量、矿区勘界测量等。在 GPS 和 GPS RTK 技术在测量方面得到应用后,使原来比较复杂的地质勘探工程测量变得简单,精度大幅度的提高。一个基准站可以支持多个移动站进行放样或者定位测量,特别是 RTK 的线放样功能在勘探网、勘探线剖面的施测中更是游刃有余,彻底摆脱了常规的勘探线测量中勘探线上障碍物的对测量的影响。RTK 灵活的测量方法使得勘探网的布设、勘探线剖面测量以及工程点的定位等测量能够同时开展^[4]。

采用传统的测量方法,勘探线端点、工程点、剖控点,由其附近的控制点用光电测距极坐标法、经纬仪视距极坐标法布设于实地。布设后的勘探线端点(即剖面线端点)及剖控点的定侧,用光电测距经纬仪极坐标法、侧角交会法等施测。作业程序繁多,精度差,

特别是采用经纬仪视距极坐标法进行测量精度无法控制。钻孔、槽探端点、坑道近井点等工程点的定测一般采用测角交会法、光电测距极坐标法进行定测。野外测量完成后还需要进行复杂的计算、检核,然后进行手工展绘勘探线剖面图、实际材料图、勘探工程布置图及地形地质图等。由于地质点大部分采用视距极坐标法测定,误差大,粗差出现率高,在制作地形地质图时地质点和地形图矛盾重重,解决起来非常麻烦。

在采用传统测绘技术的年代进行地质勘探工程测量,一个不足 10 km² 的勘探工作区,需要 3-4 个作业组(一组 4 人),驻扎勘探区,野外工作完成后还需长时间整理资料,制作图件等。工作效率低、劳动强度大、成果成图质量低,很难保障地质勘查工作的需要^[5]。

我单位在非洲某国的 3 个地质勘探项目中,采用 GPS RTK 技术进行地质勘探测量,投入 20 台 GPS 接收机,在 3 个旱季(有效作业时间总计 12 个月)中,在完成上述控制测量和地形测量外,总计完成勘探线剖面测量 1 583.7 km、钻孔放样 4 505 个、钻孔定测 4 070 个。专家验收组称该项目取得了在世界地质勘探历史上具有震动性的巨大成果,勘探时间之短、勘探面积之大、成果质量之高在国内地质找矿的历史上是前无古人,后无来者。

4 结 语

GPS 测量技术在作业速度、成果质量、劳动强度等方面具有传统测量技术无法比拟的优势。随着国产 GPS 仪器发展,GPS 接收机的单台价格从数十万元降至几万元,使得该技术在测绘行业的普及得以实现。但是 GPS 测量技术还存在一定的局限性,比如遮挡、强磁场干扰、太阳黑子及超远距离等因素都对测量质量有一定的影响,甚至可导致无法测量。坑道测量等还需要使用经纬仪、全站仪等测量仪器来完成。

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Application of Precise Point Positioning Technology to Topographic Surveying and Mapping with Middle and Small Scale

by LIU Tao

Abstract The development and progress of Precise Point Positioning (PPP) were summarized firstly in this paper. The PPP was applied to 1:10 000 map production of Xingjiang Province. The feasibility and accuracy of PPP in such application were analyzed and discussed.

Key words photogrammetric control point surveying ,GPS , Precise Point Positioning ,static positioning accuracy (Page:32)

Simulation and Analysis of Construction Land Change of Yongshan County

by ZHANG Jialong

Abstract Sustainable land use is the basis for sustainable social development and construction land change is the key factor. This paper took the surrounding areas of Yongshan County as the study area and the construction land change as the main study object. The temporal and spatial characteristics of land use change over the past 6 years has been studied using GIS and RS technology. The data source was remote sensing images in 2003 and the land use vector data in 2009. By exploring land use conversion rules and using LCM model, CA_Markov model, it had forecasted and simulated the land use change trend of Yongshan County.

Key words GIS , RS , construction land , LCM model ,CA_Markov model (Page:35)

Design and Development of 3D Terrian Visualization System Based on ArcEngine

by WANG Fangxiong

Abstract With Visual C# .NET for development platform and ArcEngine for development components,this paper detailed the implementation methods and key technologies of 3D terrain visualization functions,including building a 3D terrain,displaying scene on the surface of 3D,analysising terrain factors and visibility.Finally,we designed and realized 3D terrian visualization system based on ArcEngine.

Key words ArcEngine ,3D terrain visualization ,DEM ,terrain factor (Page:38)

Research on Conversion between SunwayGIS and CASS

by JU Feng

Abstract This paper thoroughly discussed two data formats created by SunwayGIS and South CASS, and introduced the conversion methods and conversion processes between them in detail. Then, the encoding comparative table including the structure and content was described. Finally, the all-purpose program modules were developed. The practical result indicated: the method was simple and efficient to finish conversion, which made the two data format had the same geography, the correct topology and the same attributes.

Key Words SunwayGIS ,CASS ,conversion ,encoding comparative table (Page:41)

Organization and Management of Mass Geography Information Data Based on GeoDatabase

by ZHANG Yaobo

Abstract The data of provincial foundation geography information has developed "4D" product ,that includes many types, multiscale and multi-States.The amout of data will be over 1 TB. Based on spatial data model-GeoDataBase,this paper researched how to organize and manage mass geography information.and ensured to construct the provincial database system.

Key words fundamental geographic information database ,GeoData-Base ArcSDE (Page:44)

Research on High-resolution Geoeye-1 Ortho-rectification

by SU Yiping

Abstract In this paper, according to one scene of high-resolution Ge-

oeeye-1 satellite image, a method of SAR image ortho-rectification based on the RPC model was proposed. The experiments indicated that the rms value resulting from the independent check points utilizing four control points in the corner, was 0.335m, which can meet the need of the updating of 1:10 000 ortho-images.

Key words Geoeeye-1; high-resolution satellite images; RPC model; ortho-rectification (Page:47)

Design and Application of the Three Gorges Comprehensive Information Spatial Integration Platform Framework

by ZHENG Lina

Abstract When the world-renowned Three Gorges Project and millions of immigrants project draws to the end, the focus of the Three Gorges Project reservoir area must transfer to the construction and management of maintenance up. The success of the Three Gorges Reservoir Area construction relates to the Three Gorges project and to the safety and economic & social development in reservoir. By analyzing the situation of the Three Gorges Reservoir Area Information Resources to start, from the structure, standards, space technologies and other means of multi-level integrated information space of the Three Gorges reservoir area integration platform integrated framework for project design and implementation.

Key words integrated framework, comprehensive information, spatial, Three Gorges (Page:51)

Application of GPS Technology to Control Survey in a Copper-nickel Mine

by HUANG Dahu

Abstract This paper analyzed the application of traditional GPS technology to engineering survey in a copper-nickel mine combine with an iron control net in Xianfeng county and introduced the basic circumstances of the measuring area. It emphatically introduced content of data processing.

Key words GPS ,baseline processing ,adjustment (Page:54)

Comparison of GPS and Traditional Measurement Techniques in Geological Exploration

by LI Baojie

Abstract With examples of major projects, by comparing the traditional measuring technology and GPS measuring technology in control survey, topographic survey and geological exploration engineering measurement, we considered that the GPS measuring technology had the superiority of promptness and high quality results that the traditional method can't match.

Key words GPS ,traditional measuring method geological engineering survey (Page:56)

Design and Implementation of 3S-based Land-use Change Survey Information System

by ZHAO Zhongjun

Abstract Based on analysis of procedure of land use change survey, this paper proposed the design and realization scheme of land use change survey system with 3S technology. The key issues of implementation were discussed, and the prototype system was built with Vb. Net and ArcGIS Engine. It was the beneficial exploration of building land use change survey system based on 3S technology. The existing problems and the future research trends were also mentioned in this paper.

Key words 3S technology ,investigation of land-use change ,system design ,system implementation (Page:58)

Quality Control of Digital Products with 1:10 000 DLG

by FAN Haisheng

Abstract This paper discussed the main contents and methods of quality control of 1:1 million DLG and described self-developed quality control procedures With 1:10 000 DLG data products. It researched a quality control system based on comprehensive production process.

Key words basic mapping, DLG, quality control (Page:61)