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共通地质模型和虚拟现实在地下工程规划与设计中的应用

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摘要 在矿山、地下发电站、地下核废料处理设施、地铁等地下工程的规划与设计过程中，需要把勘探(例如地质、地球物理、地球化学、地质统计、地下水、岩石特性)、工程(例如开挖布局、几何形状、应力、变形)和施工(例如工期、造价)的空间n维数据综合起来，以便作出合理的工程决策。随着勘测、分析计算与观测技术的不断提高，工程数据量和复杂程度与日俱增，在很多情况下人们仅仅利用现有数据的一小部分做出工程决策。最近，加拿大劳伦森大学开设了标志着目前科技最高水平的虚拟现实合作实验室。该虚拟现实实验室为地下工程规划和设计中所遇到的数据综合与解释提供一个独特的环境和设备，并通过将深层探矿调查及大型矿山规划和设计的例子来进一步展示如何把共通地质模型和虚拟现实这个独特的工具运用到地下工程的规划与设计中，以便领会复杂数据的空间关系，实现附加价值(如项目范围的数据综合化，改善对三维图形的理解，减少重复设计，加强项目小组之间的合作等)。最后，介绍在工程项目整体数据综合、矿山设计检验、岩石支护设计以及加拿大劳伦森大学地质力学研究中心开发的地质力学设计准则的三维可视化方面的成果和经验。

关键词 岩石力学 共通地质模型 虚拟现实 地下工程 规划与设计 地质 施工

分类号

PLANNING AND DESIGN OF UNDERGROUND ENGINEERINGS UTILIZING COMMON EARTH MODEL AND IMMERSIVE VIRTUAL REALITY

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Abstract

Planning and design of underground engineerings，such as underground mines，underground powerhouses，nuclear waste repositories，subway systems，amongst others，involves a process of complex spatial n-dimensional data integration utilizing information from field exploration(geology，geophysics，geochemistry，geostatistics，groundwater，and rock mass characteristics)，engineering(excavation placement，geometry，stress and strain) and operations(scheduling and costs). As new logging and monitoring technologies are being developed，the amount and complexity of data becomes overwhelming and，in the past，decisions are often made based on only a small part of the available data. Recently，Laurentian University in Canada opened a state-of-the-art Virtual Reality Collaboration Laboratory(VRCL)，a unique facility offering an exceptional data interpretation environment for sub-surface engineering planning and design. This facility，designed to meet the needs of the mineral exploration and mining industries，offers a team interpretation environment for earth modeling applications. The main benefit for multi-disciplinary teams is the speed with which complex subsurface models can be interpreted，explained，and evaluated. Through examples from site characterization for deep underground mines and mine planning and design，this paper demonstrates how value(project-wide data integration，improved 3D understanding，reduced engineering rework，project team collaboration) can be added to the geotechnical planning and design process of underground engineerings by utilizing this unique tool to comprehend spatial relationships of data. The paper is built on our experiences involving project-wide data integration，mine design validation，rock support planning and design，and visualization of geomechanics design criteria developed at the Geomechanics Research Center of Laurentian University in Canada. It has been proven through practical application of the VRCL technology that it is not the quantity or quality of the data，but rather the quality of the decision that is made based on the data，that renders the VRCL an invaluable resource for the industry. Recently，the first stage of a global network – Northern Advanced Visualization Network—is being built to link virtual reality centers in northern Ontario in Canada，for expertise sharing and tele-decision-making.

Key words rock mechanics common earth model virtual reality underground engineering planning and design geology construction

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