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## 二维微动剖面探测"孤石":以深圳地铁7号线为例

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Mapping spherically weathered "Boulders" using 2D microtremor profiling method: A case study along subway line 7 in Shenzhen

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摘要

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摘要 "孤石"是花岗岩不均匀风化所残留的风化核,在我国南方沿海地区普遍发育."孤石"埋藏分布随机,形状大小各异,给地铁盾构施工带来重大安全隐患,探测"孤石"一直是地铁工程勘察面临的难题.我们首次尝试利用二维微动剖面技术探测"孤石",在深圳地铁7号线车公庙—上沙段区间实测二条剖面,结合少量钻孔资料进行岩性层划分和"孤石"解释.实测结果显示,在二维微动视S波速度剖面上,素填土、粉质粘土、砾质粘土等岩土层、全风化、强-中风化、微风化和未风化的花岗岩层,视S波速度值各不相同,剖面特征也存在较大差异,利用少量钻孔结果标定,易于划分;在强-中风化花岗岩层中,视S波速度(岩性)横向变化剧烈,局部发育"团块状"高速体,本文将之解释为未风化的花岗岩"孤石".本文结果表明,二维微动剖面技术探测"孤石"是有效的微动视S波速度剖面除能直观显示岩性的纵、横向变化,提供工程基岩面的埋深及起伏形态信息外,还可给出岩土层风化程度的判断信息,为高层建筑的桩基设计提供地球物理依据.作为一种全新的"孤石"探测手段,二维微动剖面技术尤其适用于交通繁忙、建筑物密集的、各种场源干扰严重的闹市区.

关键词 二维微动剖面, 微动探测, 视S波速度, "孤石", 地铁工程勘察

Abstract: A "boulder stone" is referred to the remnant of a granite body which has been unevenly weathered. These "boulders" become a common geological feature in areas close to the shoreline in south of China. They are typically randomly distributed and buried in soil or weathered rocks with varying shapes and sizes. Their existence poses a serious operational risk to the subway tunnel construction. Boulder detection has been a difficult problem in geotechnical investigation and surveying for subway building. This paper documents the first application of a 2D microtremor profiling method to map spherically weathered "boulders". Principles of the method will be described followed by real application examples. Two microtremor profiles were obtained between Chegongmiao and Shangsha along subway line 7 in Shenzhen. The microtremor data, combined with limited drilling data, were used for lithostratigraphic classification and boulder interpretation. On the 2D profiles, we observed different apparent S-wave velocity values for different lithologic sediment layers, such as plain fill, silty clay, rudaceous sediments. In particular, there appeared a strong correlation between apparent S-wave velocity and the degree of weathering of the granitic layers (namely completely, strongly, moderately, slightly, and non-weathered). With the help of limited drilling data, it is possible to quantify, at least qualitatively, the degree of the granite weathering from the apparent S-wave velocity characteristics. Local high apparent S-wave velocity anomalies in otherwise moderately to strongly weathered granitic layers interpreted as unweathered "boulders". Our results demonstrate that the 2D microtremor profiling is a very effective technique for "boulder" detection and mapping. The lithological variation and weathering in both vertical and horizontal directions, the depth of the bedrock and its undulating configuration can be shown clearly in 2D microtremor apparent S-wave velocity profile. Therefore, the method can also provide geophysical basis for designing the pile foundations for the high-rise buildings. As a new method for "boulder" detection and mapping, the 2D microtremor profiling method is particularly useful in

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densely-populated urban areas with crowded high-rise buildings and heavy traffic.

Keywords [2D Microtremor profiles](#), [Microtremor survey](#), [Apparent S-wave velocities](#), "[Boulder](#)", [Subway engineering investigation](#)

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