

Utilisation of X-Ray computed microtomography for evaluation of iron sulphide distribution in roofing slate

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Roofing slate represents a traditional natural stone used for centuries for roofing and other construction applications in various types of buildings. Quality roofing slate must be primarily splittable into large, thin and waterproof tiles. In addition, it must be stable in colour and resistant against weathering. The abundance of mineral phases that weather easily or minerals that are long-term unstable has the effect of reducing the durability of slates in exterior conditions. One of the most problematic rock components, which are in a larger or smaller extent present in almost all slates, are iron sulphides, such as pyrite, marcasite or pyrrhotite. Under common atmospheric conditions, these minerals tend to oxidise, which leads to the formation of limonite and sulphuric acid. As a consequence of the origin of red-brown Fe oxyhydroxides, the undesirable colour changes of the slate may occur. But the most serious problem which occurs during this process is the changes in volume. This can cause disintegration of slate depending on the form of the iron sulphide occurrence.

The content and size distribution of iron sulphides in roofing slate is normally determined using the microscopic analysis in transmitted light, combined with the observation in reflected light. For quantitative determination of iron sulphides in slate, the X-Ray powder diffraction is also often used. The results of the microscopic and X-Ray analyses need to be mutually compared and should not differ fundamentally.

This paper is focused on the assessing the possibility of application of the X-Ray computed microtomography (CT) as a new complementary technique enabling the analysis of content and size (volume) distribution of iron sulphides in roofing slate. The X-Ray CT study was conducted using an XT H 225 ST industrial microtomographic system made by Nikon Metrology NV. Studied samples were reconstructed using the CT Pro 3D software (Nikon Metrology NV). The visualisation and analysis software VGStudio MAXx 2.2 (Volume Graphics GmbH, Germany) was used for subsequent imaging. The research was performed on samples of Ordovician slate from Luarca Formation in northern Spain. Based on the X-Ray CT investigations it was found that the content of iron sulphides in Luarca slate ranges between 0.29 % and 0.33% depending on the chosen threshold. Fully identical presence of iron sulphides in Luarca slate, ranging around 0.3%, was determined using the petrographic analysis carried out on the same slate samples. In addition to the optical microscopy, the methods of the X-Ray powder diffraction and separation using heavy liquids were used to verify the results of the X-Ray CT study.

The presented results of the pyrite volume analysis in the Luarca slate using the X-Ray CT and their initial comparison with the results of petrographic analyses have comparable outcomes. The main advantage of the X-Ray CT is, in particular, the possibility of spatial distribution analysis of iron sulphides. The X-Ray CT analysis therefore represents a rapid, effective and modern alternative technique applicable for the determination of harmful components in roofing slate represented by iron sulphides.