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3D crack aperture distribution from a nuclear imaging method

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Cracks in solid rocks are multi-scale entities because of their spatial, length and aperture distributions. Aperture distributions of cracks are not well known because their full aperture range (<0.1 μm to >1 mm) is not accessible using common imaging techniques, such as SEM or X-Ray computed micro-tomography. Knowing the aperture distribution or cracks is, however, highly relevant to understanding flow in rocks. In crystalline rocks the lack of knowledge about the crack aperture distribution keeps us from a clear understanding of the relationships of porosity and permeability. A nuclear imaging method based on the full saturation of connected rock porosity by a 14C-doped resin (the 14-C PMMA method) allows detecting the connected microcrack network using autoradiography. Even if cracks are detected only on 2D sections, an estimate of the 3D aperture distribution of these cracks is possible. To this end, a set of "artificial crack" standards was prepared and investigated. These standards consisted of a PMMA layer of known thickness between two glass plates. Analysis of experimental autoradiographic profiles around these artificial cracks allows determination of their aperture. This methodology was then applied to different rock samples, mainly granitic ones.