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Reaction-assisted hierarchical fracturing during serpentinization

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Hierarchical fracture patterns are the result of a slowly driven fracturing process that successively divides the rocks into smaller domains. In a 2D (outcrop) section such fracture patterns are characterized by four sided domains, and T-junctions where new fractures stop at right angles to pre-existing fractures. Here, we describe fracturing of mm to dm thick serpentinized orthopyroxenite dykes in a dunite matrix from the Leka Ophiolite complex in Nord-Trøndelag, Norway. The fracturing process is driven by volume changes associated with the serpentinization of the dunites. During this process the orthopyroxenite dykes are 'squeezed' by the expanding dunite and undergo extensive fracturing. The resulting fracture patterns have all the characteristic feature of hierarchical patterns, including a power-law distribution of cumulative fracture lengths. Reaction-assisted hierarchical fracturing is also likely to be responsible for other structures commonly observed in serpentinized ultramafic rocks, including the mesh-textures of the individual olivine grains, and the high abundance of rectangular domains at a wide range of scales. Such mechanisms may provide first-order controls on fluid migration rates in a wide variety of geological settings.