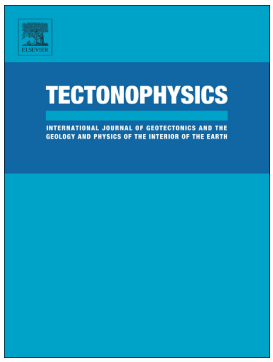

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Spatial and size distributions of garnets grown in a pseudotachylyte generated during a lower crust earthquake

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Abstract

In the Bergen Arc, western Norway, rocks exhumed from the lower crust record earthquakes that formed during the Caledonian collision. These earthquakes occurred at about 30-50 km depth under granulite or amphibolite facies metamorphic conditions. Coseismic frictional heating produced pseudotachylytes in this area. We describe pseudotachylytes using field data to infer earthquake magnitude ($M \geq \sim 6.6$), low dynamic friction during rupture propagation ($\mu_d < 0.1$) and laboratory analyses to infer fast crystallization of microlites in the pseudotachylyte, within seconds of the earthquake arrest. High resolution 3D X-ray microtomography imaging reveals the microstructure of a pseudotachylyte sample, including numerous garnets and their corona of plagioclase that we infer have crystallized in the pseudotachylyte. These garnets 1) have dendritic shapes and are surrounded by plagioclase coronae almost fully depleted in iron, 2) have a log-normal volume distribution, 3) increase in volume with increasing distance away from the pseudotachylyte-host rock boundary, and 4) decrease in number with increasing distance away from the pseudotachylyte -host rock boundary. These characteristics indicate fast mineral growth, likely within seconds. We propose that these new quantitative criteria may assist in the unambiguous identification of pseudotachylytes in the field.

Keywords: lower crust, earthquake; pseudotachylyte; garnet; Bergen Arc

Highlights

- Source parameters of $M \geq \sim 6.6$ lower crust fossil earthquakes estimated
- Coseismic slip produced a melt layer (pseudotachylyte) with extreme lubrication
- Garnet grew in the pseudotachylyte within seconds after the earthquake
- The shape, size and spatial distribution of these garnets provide additional criteria to recognize pseudotachylytes