Goldschmidt 2000
September 3rd–8th, 2000
Oxford, UK.

Journal of Conference Abstracts
Volume 5(2), 812
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An Analytical TEM Study on Complex Zoning Patterns in Garnets from Bergen Arcs Eclogites

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Eclogite facies rocks within the Bergen Arcs, western Norway, have formed from granulites along shear zones and fluid pathways. Garnets that were inherited from granulite facies protoliths show different types of compositional zoning due to an incomplete eclogitization process including concentric rim zoning, zoning along vein fillings and inclusion trails, and zoning bands without inclusions [1]. The bands are interpreted as channels in which fluid strongly raises the element mobility. As the re-equilibration of these garnets is strongly dependent on the presence of fluid and deformation (fractures), there are basically two mechanisms that were able to form the complex zoning patterns: volume diffusion and a dissolution-reprecipitation process. The resulting zonation profiles due to these mechanisms are expected to be quite different. Volume diffusion produces a compositional gradient over a certain length scale, whereas a dissolution and reprecipitation process results in compositionally distinct regions separated by an narrow opening in which the fluid migrates. Since a combination of both processes is likely, an extensive knowledge of compositional changes connected with microstructural observation on the nm-scale is required to distinguish them and eventually to make an estimate on their extent. Therefore, we present quantitative results of analytical transmission electron microscopy (ATEM) using energy dispersive spectroscopy (EDS), electron energy loss spectroscopy (EELS) and electron spectroscopic imaging (ESI) from the interfacial part of the zonation pattern which is characterized by a steep compositional gradient with an increase in Fe-content (X_{Alm} ~0.31 to 0.54) coupled with a decrease in Mg-content (X_{Pyr} ~0.50 to 0.25). The zonation profiles and the underlying mechanisms will be discussed against the background of the effect of parameters such as fluid infiltration, deformation (fracture density) and temperature-pressure changes.

Erambert M & Austrheim H, *Contrib. Mineral. Petrol.*, **115**, 204-214, (1993).