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The effect of phase abundance on the rheology of eclogites – a study based on deformation experiments

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Owing the formation and presence of potentially large amounts of eclogite their deformation behaviour is of great importance for the rheology of the lithosphere in continental collision and subduction zones. The rheological behaviour of polymineralic rocks depends on the relative amount, the distribution and the strength of its components. In the presented study, we constrain the rheological behaviour and microstructural evolution of synthetic eclogite samples, composed of omphacite and garnet in varying fractions, by deformation experiments at a range of temperatures and strain rates. Samples are synthesized in a piston cylinder apparatus to control the relative proportions of omphacite and garnet. The conventional triaxial compression experiments are performed in a modified Griggs apparatus at temperatures and pressures characteristic for in-situ conditions at plate boundaries. Microstructures of deformed samples are characterized by a distinct foliation defined by a strong shape preferred orientation of omphacite and garnet. Elongate omphacite crystals are aligned perpendicular to the shortening direction. In samples deformed at 900°C undulatory extinction and deformation lamellae document crystal plasticity accommodated by dislocation glide. The presence of recrystallized grains in samples deformed at higher temperatures indicates the onset of dislocation climb and associated recovery mechanisms. Garnet tends to cluster and form tailed aggregates perpendicular to the shortening direction. The tails are possibly formed by fragmentation of the initial garnet crystals but also by recrystallization. Deformation within large garnet crystals (>40μm) is mostly brittle as indicated by cracks aligned with the maximum compressive stress. Strength of samples increases with garnet content. However, further research is necessary to identify active deformation mechanisms in omphacite and garnet and to determine rheological flow laws for eclogite depending on the relative proportions of omphacite and garnet.