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Transforming eclogite into mafic mylonite (Songshugou, Qinling Belt, China)

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Inclusions, reaction textures, and the compositional zoning of minerals are telling records of metamorphic processes and windows into Earth's interior. Evolving pressures, temperatures, water activities, and oxygen fugacities may cause the obscuration of these features—they become ambiguous and difficult to interpret. This contribution discusses examples of such modifications in eclogites and shows limitations for quantitative thermobarometry.

The eclogites detailed herein occur as lenses and layers in mafic mylonite. They stem from the north-eastern section of the Qinling Belt, China, and are instances of a limited number of dismembered bodies of (ultrahigh-pressure) eclogites, which formed in a subduction–accretion system ∼520–485 Ma ago.

The best-preserved eclogites mainly consist of garnet and extensive clinopyroxene(III)–plagioclase symplectites, which mantle relics of clinopyroxene(I+II). Garnets show prograde zoning and include clinopyroxene(I+III), plagioclase with concentric zoning, K feldspar in contact with epidote, amphibole surrounded by compositional halos in garnet, prehnite, pumpellyite, epidote, rutile, ilmenite, and titanite. In the matrix, clinopyroxene(I) is in contact with nearly Na-free but oriented orthopyroxene rods-hosting clinopyroxene(II); both are mantled by the symplectites. The symplectites are separated from garnet by amphibole coronas.

In eclogites with poor garnet and clinopyroxene preservation, amphibole-rich cleavage domains wrap around amphibole porphyroclasts and garnets with plagioclase–amphibole–clinozoisite coronas. The amphibole porphyroclasts have whitish actinolite cores, which sometimes contain nearly Na-free clinopyroxene, and brown pargasite–hornblende rims; at the core-rim interface, oriented rods of quartz and plagioclase precipitated.

The mafic mylonite shows amphibole-rich cleavage domains and stretched ribbons of plagioclase with minor amphibole and clinozoisite.

The principle results are: (1) Host–inclusion reactions in garnet, perhaps facilitated by diffusional component exchange with the matrix, led to concentric zoning in plagioclase inclusions and compositional halos in garnet around amphibole; all these inclusions cannot be used for conventional thermobarometry. The modification of inclusions happened even at rather low temperatures given the presence of prehnite and pumpellyite. Early mineral assemblages may be discussed with the help of phase diagrams but they can hardly be deduced solely from textures. Phase equilibria modelling revealed 1.93–2.54 GPa, 462–542°C for the growth of garnets with the highest Mn and lowest Mg content in the cores, assuming their zoning was negligibly modified after growth. (2) The highly stretched ribbons in mafic mylonite are the end-point of a continuous decomposition of garnet: During exhumation, garnet first was mantled by coronas at 0.7–1.2 GPa, 660–710°C. During an isothermal uplift to 0.5–0.8 GPa, these coronas evolved into stretched ribbons. (3) Clinopyroxene(I), stable at the pressure peak, evolved into an orthopyroxene-bearing solid solution at the temperature peak and was decomposed to clinopyroxene(III)-plagioclase symplectites during retrogression. (4) The zoning of the amphibole porphyroclasts reflects the limited availability of components in the centre of a corona but not continuous growth: Amphibole coronas first mantled the symplectites and the symplectites then were transformed into the whitish cores. (5) K feldspar–epidote inclusions in garnet are relics of melt; together with the exsolutions of orthopyroxene in clinopyroxene(II) they confirm significant heating during uplift.