Orogenic eclogites as recorders of deep crustal flow

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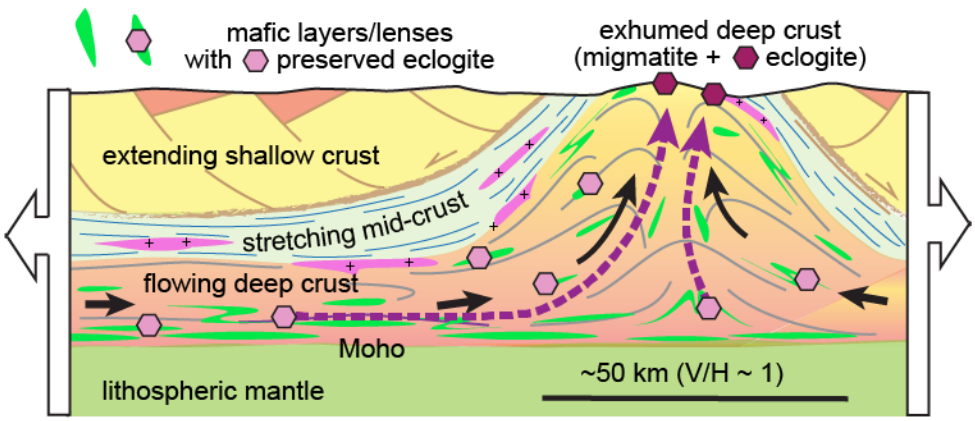
Eclogite enclosed in gneiss or migmatite occurs in many exhumed hot orogens. Commonly, both eclogite and host experienced coeval high-pressure (HP) metamorphism, although there are cases in which eclogite has been tectonically-included in non-HP rocks. In the more typical case of coeval HP metamorphism, eclogite and gneiss represent a deep crustal flow system that reveals large-magnitude transport: laterally prior to exhumation, then vertically during exhumation from near-Moho depths. The extent of deep-crust lateral flow is difficult to document, but eclogites in migmatite provide clues as to whether deep crust flowed long distances (>tens of km) or whether exhumed deep crust was more locally sourced.

We have reconstructed the flow paths of orogenic eclogite in migmatite from the southern French Massif Central (FMC) using mineral and rock composition (bulk, mineral major/trace elements; O isotopes in zircon and garnet; bulk Sm-Nd, Lu-Hf, Rb-Sr), textures (inclusions, symplectites), extent of zircon recrystallization, and deformation fabrics. Because eclogite and host shared a flow history, we can detect the provenance of the host migmatite. For example, in the Montagne Noire migmatite dome, we can distinguish between eclogite that experienced protracted high-temperature metamorphism and deformation during flow in the deep crust from eclogite that was more locally-sourced. Ongoing work is applying this methodology to eclogites and other mafic rocks in the FMC, including distinguishing between eclogites formed in subducted oceanic crust vs. deep orogenic crust.



Schematic cross-section showing far-traveled and more locally-sourced deep-crustal rocks exhumed in the same extensional gneiss/migmatite complex.