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ECLOGITES IN MIGMATITES: EVIDENCE FOR EXHUMATION OF LARGE VOLUMES OF DEEP CRUST

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Eclogite lenses and layers in migmatite have been described in many orogens in the past century (e.g. Eskola 1921). The relationship of high-pressure (HP) metamorphism of eclogite inclusions to the moderate/low-P conditions recorded by host gneiss has been discussed and debated for decades (e.g. Coleman et al. 1965) because significant information about metamorphic and tectonic processes can be gleaned from eclogites and host gneiss. Key examples of eclogite-in-migmatite are in the Variscan, Caledonian, and Alpine-Himalayan orogens. Although eclogite may occur as tectonic lenses in gneiss that did not experience HP metamorphism, more commonly, both rock types experienced HP metamorphism but only eclogite preserves an obvious record of it.

In the Variscan Montagne Noire migmatite dome, French Massif Central, eclogite in 2 localities – one in the dome core, one at the margin – had similar gabbro protoliths with the same crystallization age as migmatite protoliths. Both eclogites experienced HP metamorphism that was broadly coeval with crystallization of migmatite. Abundant amphibolite has similar bulk composition as eclogite, indicating that the amphibolites are likely retrogressed eclogite and therefore much of the dome was deeply sourced. However, the 2 eclogites differ in degree of preservation of protolith zircon, record of prograde metamorphism, peak T, and deformation history, providing information about eclogite trajectories from source to emplacement and variation of fluid-rock interaction during metamorphism. Further insights into sources, trajectories, and thermal/melting history of dome rocks is provided by numerical models, including prediction of how the deepest (near-Moho) crust is exhumed to the shallowest levels, inverting crustal structure and emplacing migmatitic sheets above crust that remained below the solidus.

In the Montagne Noire, zircon in dome-core eclogite records an amphibolite facies event that has not been recognized in host migmatite but that is widespread elsewhere in the Massif Central. This may be an indication that domes are the shallowly-emplaced manifestations of vast, connected, deep crustal flow systems that underlie large regions of hot orogens. This hypothesis remains to be tested by integrated petrology/geochemistry and numerical modeling.