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Nappe scale coherent block exhumation from eclogite-facies conditions revealed by Lu-Hf garnet chronometry – the Adula Nappe (Central Alps)

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The Adula Nappe in the Central Alps (Switzerland and Italy) is derived from the former continental margin of the European Plate that was subducted beneath the Adriatic Plate during the Alpine orogenic cycle. It mainly consists of various gneisses with layers of garnet-micaschist, marble, and bodies of mafic and locally of ultramafic rocks. High-pressure and ultra-high-pressure conditions are preserved in eclogite and ultramafic rocks but are virtually absent in gneisses and thus in the bulk of the nappe. It is unclear wether the unit was assembled after peak-pressure conditions from units with very different PTt-histories or was exhumed as a more or less coherent block from peak pressure conditions.

Eclogite samples from the central Adula Nappe are characterised by the presence of two populations of garnet. A first generation of garnet shows a Variscan Lu-Hf age, a second one an Alpine (Late Eocene) age (Herwartz et al., 2011; this study). In the southern Adula Nappe Alpine metamorphic conditions completely reequilibrated Variscan assemblages and garnet reveals exclusivly Eocene Lu-Hf ages. In contrast, garnet was almost unaffected by Alpine metamorphism and is exclusively of Variscan age in the northern Adula Nappe. Hence, the degree of Alpine metamorphic overprint and Lu-Hf age reequilibration is maximal in the southern part of the unit and decreases towards the north. Isotopic ages are in line with microstructural observations and major element maps of garnet. Element maps display fully equilibrated garnet in the southern Adula Nappe, i.e. garnet with a homogeneous composition due to diffusive reequilibration of probably Alpine age. In the central Nappe, relicts of an older, partly requilibrated generation (Variscan), are overgrown by a garnet generation with prefectly preserved prograde zonation and no diffusive overprint during the Alpine cycle. Towards the northern Adula Nappe, the Alpine generation becomes less abundant and almost impossible to separate.

As garnet ages are about the same through the entire nappe and the gradient of Alpine metamorphic overprint in high-pressure assemblages is continuous, we propose that the Adula Nappe essentially remained coherent during Eocene subduction and very intense coeval and subsequent deformation. The host rocks of eclogites that don't record peak-pressure conditions (i.e. the gneisses) must have shared high-pressure metamorphic conditions.

References

Herwartz, D., Nagel, T.J., Münker, C., Scherer, E.E. & Froitzheim, N. (2011). Tracing two orogenic cycles in one eclogite sample by Lu-Hf garnet chronometry. Nature Geoscience, 4, 178-183.