How serpentine peridotites can leak through subduction channels

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Serpentinized peridotites are weaker than other mantle rocks, with an internal friction coefficient \( \mu \approx 0.3 \) vs. \( \approx 0.6 \). Therefore they often promote strain localization. Serpentinite is also considerably lower in density \( (r=2.5-2.6 \text{ g/cm}^3) \) than most rocks. In the presence of denser material, its buoyancy can mobilize upwelling masses and aid exhumation. Serpentinized peridotites can therefore influence the evolution of tectonic plate boundaries: their presence enhances shear processes, and serpentinite-hosted faults can evolve into zones of permanent lithospheric weakness that can be reactivated during different tectonic phases. Fault reactivation also provides paths for fluid infiltration and upward remobilization of serpentinized peridotites that can also interact diapirically with overlying rocks.

We have compiled observations that document the near-surface journey of serpentinized peridotites that are exhumed during rifting and continental break-up, reactivated as buoyant material during subduction, and ultimately emplaced as ‘ophiolite-like’ fragments within orogenic belts. This lifecycle is particularly well documented in former Tethys margins that now subduct beneath the Calabrian Arc. Here recent studies describe serpentinized peridotites that diapirically rose from a subducting lithospheric slab to be emplaced into the accretionary prism in front of the continental arc. We show that this newly recognized mode of subduction-linked serpentine diapirism from the downgoing lithospheric slab is consistent with the origin of some exhumed mantle rocks in the Apennines, with these assemblages having been ultimately emplaced into their present locations during Alpine Orogenesis. Transfer of serpentinized peridotites from the mantle lithosphere of the subducting slab to the overriding plate motivates the concept of a potentially “leaky” subduction channel. In addition to passing vertically through a shallow subduction channel, weak serpentinite bodies may also rise into and preferentially migrate within the intraplate shear zone, leading to strong lateral heterogeneities in its composition, mechanical strength and seismic characteristics.