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What goes into subduction?

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The type of lithosphere reaching subduction zones has profound implications for the evolution of orogenic belts and for mass balance calculations in the subduction factory. Numerical and conceptual models of subduction generally distinguish between only two types of lithosphere: (1) oceanic and (2) continental, with the latter consisting of subcontinental mantle and a 20-30 km thick crust, overlain by pre-, syn- and post- rift sediments. However, recent studies of present day rifted margins provided compelling evidence of the existence of a third type of transitional lithosphere between typical 'oceanic' and 'continental' lithosphere. Such domains, which can be up to 200 km wide, have been labeled Ocean-Continent Transition Zones (OCTZ). They are characterized by the presence of windows of exhumed mantle between slivers of hyper-extended and hydrated continental crust resting upon serpentinized mantle. Pre-rift sediments are present only rarely as extensional allochthons and syn- and post- rift sediments seal the extension-related lithostratigraphy.

Our study indicates that several high pressure units of the Western Alps that consist largely of continental-type basement derive from such transitional domains, which were formed along the margins of the Jurassic Tethys. The Sesia Zone, in the Western Alps, can be subdivided into three sub domains, which are commonly labeled 'Eclogitic Micaschist Complex' (EMC), 'Gneiss Minuti Complex' (GM) and 'Seconda Zona Diorito-Kinzigitica' (2DK). They consist of predominant Paleozoic continental basement associated with rare Jurassic serpentinites and Jurassic/Cretaceous sediments and they underwent blueschist to eclogite facies metamorphism in the Cretaceous, during the Alpine orogeny.

Slivers of serpentinized subcontinental mantle are commonly found along the edges of the EMC. Microstructural studies show that, prior to serpentinization, the original peridotites underwent mylonitization and re-equilibration at depths <30 km. Locally, evidence of pre-Alpine cataclasis along the serpentinite-continental basement contact is preserved. Exposure at the seafloor is indicated by the deposition of Jurassic radiolarites directly above the Pesmonte serpentinite in the Canavese zone, located in the proximal Adriatic margin, to the east of the Sesia Zone.

A Mesozoic sedimentary cover is preserved locally in the EMC and, more abundantly, in the GM. In both cases dolomitic limestones and marbles, which represent the typical pre-rift sediments of the Adriatic margin, are conspicuously missing. Palaeozoic basement is directly overlain by a variable thickness of meta-arkoses, Jurassic metacherts and post-rift calcschists.

Therefore, the different units of the Sesia Zone preserve a relationship between continental basement, exhumed peridotites and sedimentary cover typical of the distal part of extended continental margins and of OCT's. In such areas, (1) pre-rift sediments are missing because the continental basement is exhumed during the rifting stage at the footwall of low-angle detachment faults, and (2) serpentinites are exposed at the seafloor in mantle windows.

This study indicates that large gneissic terranes found in metamorphic belts may sample extensional allochthons derived from hyper-extended continental crust. Therefore, in those circumstances, gneissic terranes do not represent small slivers scraped off larger microplates of continental lithosphere that have gone into subduction. These results have important implications for the geochemical and geodynamic evolution of convergent plate margins, implying that large masses of continental crust are not necessarily recycled in the mantle during orogenesis.