Geophysical Research Abstracts
Vol. 21, EGU2019-4887, 2019
EGU General Assembly 2019


# The rock record of deep sediment underplating: Implications for crustal recycling and delivery of volatiles to the mantle

Carolyn Tewksbury-Christle (1), Whitney Behr (1), and Mark Helper (2)

(1) Department of Earth Sciences, ETH Zürich, Zürich, Switzerland, (2) Jackson School of Geology, University of Texas at Austin, Austin, Texas, United States

Subduction zones play a significant role in mass and volatile recycling. Previously published mass balance estimates suggest that erosive subduction margins supply almost 60% of the continental material and 35% of the total carbon subducted to the upper mantle. Calculations for these erosive margins, however, rely on assumptions of subduction of the entire sediment pile, along with any overriding plate material entrained during subduction erosion, into the mantle. Our work in the Condrey Mountain Schist (CMS), an exhumed subduction complex in northern California, provides evidence for deep underplating in an erosive subduction margin. The CMS is composed predominantly of blueschist-facies graphitic mica schist intercalated with km-scale pods of epidote blueschist and serpentinite and underplated at 35 km (480 °C, 1 GPa). The graphitic mica schist represents a hemipelagic protolith with limited terrigenous input, suggesting a sediment-poor setting typical of erosive margins. Major element geochemistry from relict chrome spinels in the serpentinites is not consistent with an abyssal peridotite source but is consistent with prior research on the Josephine Ophiolite, which occupied the hanging wall during subduction. We interpret these serpentinites as having been entrained from the overriding plate during subduction erosion. The CMS complex, however, has a structural thickness of 11 km, thicker than the 400 m average for incoming sediment piles in erosive margins. A detrital zircon transect across the structural thickness of the CMS, in conjunction with a minor inverted geothermal gradient measured via graphite crystallinity and associated thermal modeling, indicates protracted underplating at depth from 150-135 Ma. Despite erosion along the shallow subduction interface, sediments were underplated deeper along the subduction interface and did not reach the depths of arc magma genesis or deeper.

Evidence from the CMS can be used to revise mass and volatile budget estimates by accounting for deep underplating in erosive margins. We have estimated the minimum cross sectional area of the CMS measured perpendicular to the strike of the trench using the exposed structural thickness and previously modeled gravity data. Using the range of Farallon plate paleovelocities during CMS underplating and the average thickness of pelagic sediments in modern subduction trenches after a correction for dewatering and compaction, the CMS represents 17-63% of the incoming sediment. Projecting the average loss due to underplating in the CMS to global mass balance calculations for modern erosive margins results in a 10-35% decrease over previous estimates in continental material subducted to the upper mantle. This increase in estimated preservation of continental material may be indicative of an increasing modern continental crustal volume. Furthermore, updated global estimates for total carbon subducted (44-55 Mt/yr) are comparable to or less than estimates of degassing in modern arc and forearc settings (55 Mt/yr). This result suggests limited flux of carbon beyond the depths of arc magma genesis. By constraining deep underplating in a fossil erosive subduction zone, we have identified an additional significant input to mass and volatile recycling calculations.