Petrologic constraints on mélange diapir formation

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The importance of mélange diapirs in subduction zone processes (e.g. arc volcanism, exhumation of subduction zone interfaces, etc.) remains controversial. Previous work suggests that density contrasts between material on the down-going slab and the overriding plate allow for buoyancy-driven diapiric ascent of “cold plumes” into the mantle wedge. Decompression melting of this material would provide a source of melt for arc volcanism unique from the traditional MASH (melting, assimilation, storage, homoginization) model. To investigate the petrologic controls on mélange diapir formation, stable mineral assemblages and associated bulk densities for both mélange matrix and the over-riding mantle wedge during progressive metamorphism were modeled for a range of compositions observed in exhumed terranes. The models were assessed to determine where the highest density contrast between the mélange and over-riding plate exists, placing constraints on where Rayleigh-Taylor instabilities are most likely to form. Instabilities have the highest probability of forming between 600-650°C, corresponding to a formation depth of ~60km (assuming a slab-top geotherm of 12°C/km and a slab dip of 20°C). These results were integrated into a multidisciplinary model of mélange diapirs developed during the 2017 NSF/FESD CIDER summer workshop. This model incorporates petrology, geochemistry, geodynamics, seismology, and geodesy to predict where mélange diapirs are likely to form and ascend, and what their geochemical and geophysical tracers would be. Multidisciplinary approaches, as presented here, are essential to the development of a more thorough understanding of complicated geologic processes, such as mélange diapirs, that may not be possible using traditional, specialized techniques.