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Fore-arc mantle metasomatism produces magnetotelluric anomalies in geophysical images of subduction zones

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Subduction of oceanic crust buries an average of 300–500 m of sediment that eventually dehydrates or partially melts. Progressive release of fluid/melt metasomatizes the fore-arc mantle, forming serpentinite at low temperatures and phlogopite-bearing pyroxenite where slab surface reaches 700–900 ºC. This is sufficiently high to partially melt subducted sediments before they approach the depths where arc magmas are formed. Hence, the reaction of volatile-bearing partial melts derived from sediments with depleted peridotite forms mica-pyroxenite already within the fore-arc of a subduction zone. Modelling the magnetotelluric anomalies of such metasomatic assemblages closely reproduces those anomalies that are observed for the Cascadia and Kyushu subduction zones. Melting of subducted sediments may further explain K-rich volcanic rocks that form when the mica-pyroxenites melt during slab roll-back. Furthermore, since melt and mica both have low frictional strength, damaging thrust earthquakes are unlikely to occur in the vicinity of the metasomes, while increased fluid pressures may promote the occurrence of small magnitude earthquakes and episodic tremor and slip.