Influence of Subduction Parameters on Wedge Melting

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To investigate the role of subduction parameters on melting of the wedge, we have investigated corner flow models with plate age varying from 10 to 150Ma, subduction angle (B) from 30° to 80°, thickness of the overlying lithosphere (h2) from 15 to 70km, and convergence rate (U) from 4 to 16 cm/yr. A hydrous melting model that takes into account mantle temperature and source water content has been applied to thermal profiles extending from the slab at 150km to the base of the lithosphere. The length of the melting column and maximum extent of melting can then be parameterised as functions of subduction parameters.

Many aspects of wedge thermal structure can be related to the Peclet number, which is proportional to the product of convergence rate (U) and slab angle (B). The age of the incoming plate has no influence on wedge thermal structure. Slow U causes thickening of the boundary layer in the wedge above the slab. Small B causes the cool temperatures of the wedge corner to extend further into the wedge. Thicker h2 deepens the top thermal boundary layer causing lower wedge temperatures for a given depth. For any lithospheric thickness, maximum extent of melting (Fmax) is a linear function of UB to a power. Slopes of these functions are simply related to lithospheric thickness, permitting a single equation for Fmax as a function of subduction parameters. The parameterisation can be applied to global convergent margins using subduction parameters appropriate to each margin. Including U nd B markedly improves (R-squared of 0.85 vs. 0.55) earlier correlations that had been observed between crustal thickness and Na8 (which serves as an index of partial melting). Quantitative fit to the data is improved if there is a component of decompression melting in the wedge.

Lu-Hf geochronology of UHP metamorphism in the Zermatt-Saas ophiolite, Lago di Cignana, Italy

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Lutetium-hafnium data from ultra high pressure MORB-type metabasic rock (sample: 96-JA-32) from the Lago di Cignana area, Valtournanche, western Alps, Italy has yielded an impure garnet (inclusion rich)--whole rock isochron age of 49.0± 3.3 Ma. The UHP mineral assemblage is typically garnet + omphacite + blue amphibole + clinozoisite/zoisite + white mica + rutile. Garnets are poikiloblastic and are rich in Ti bearing phases such as titanite and rutile. Lawsonite pseudomorphs in the Mn-rich cores of garnet document the early prograde high-pressure path.

Lu-Hf analyses were performed on a Micromass IsoProbe at UW-Madison. True external reproducibility for the whole rock samples is 0.45 ♏-units for roughly 25ng Hf analyzed of both spike subtracted and unspiked samples. Spike-sample equilibration was confirmed for our sample dissolution protocol with 5 physical mixtures of 1 Ga hornblende and garnet over a range of $^{176}Lu/^{177}Hf$ that all plot on a mixing line within error.

Sample 96-JA-32 was previously analysed for Sm-Nd and yielded a garnet-pyroxene/whole rock isochron age of 40.6±2.6 Ma (Amato, et al, 1999). The older age determined with Lu-Hf may be a related to fractionation of a large part of the Lu budget into the garnet early in its growth relative to Sm (D_{Lu}/D_{Sm} ⊛ 28 for garnet). U-Pb zircon yielded 44.1±0.7 Ma (Rubatto, et al., 1997), but it is difficult to date directly the metamorphic mineral assemblage of which P and T estimates are derived. An Rb-Sr isochron of WR-white mica from Cignana quartzite gave an age of 37.9±0.07 Ma and is interpreted to represent cooling below 500°C (Amato, et al., 1999). Comparison of Lu-Hf ages with Sm-Nd suggests the garnet growth may have been protracted or episodic and that HREE zoning may be strong from core to rim. Eclogite facies metamorphic conditions may have lasted about 10 Ma for these samples and the age of coesite formation in garnets from Cignana pelitic shcists (P=2.6-2.8 GPa; Reinecke, 1991) is likely between 40 and 49 Ma.

References

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