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Volume changes during water-assisted melting and their effect on the structures of deformation

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Deformation of the ductile crust is generally expressed as a change in length induced by differential stresses at constant volume. However, areas of partial melting are an important exception of this view of deformation, because large volume changes take place upon melting and even more dramatically during melt segregation of these rocks. The amount of volume change is controlled by the type of melting reaction, i.e. dehydration melting vs. water-assisted melting, and by the P-T conditions. Two end-member scenarios can be envisaged: (1) fluids were generated within the volume of observation, where they coexisted with solids and melts; (2) fluids were introduced in the rock, from outside. In the first case, partial melting slightly decreases or does not change the volume of the system. This result has been often used to state, that melt segregation is difficult during water-assisted melting. However, on the scale of hand samples and outcrops such rocks do not store enough fluids to produce significant melt fractions (volumes are $<<$ 0.1 vol%). In contrast, in the case of infiltrating fluids (case 2), significant changes of volumes occur upon melting, and these have to be accommodated by deformation and melt flow. These deformations are not induced by regional stress fields, but by the volume changes of the melting reaction. Therefore, the structures of migmatites generated by water-assisted melting are expected to be different from the structures of migmatites formed by dehydration-melting. We predict the following structural features to affect the former type of migmatites: (1) Overprinting relations of leucosomes may be related to water recycling within migmatites of initial granitic composition. (2) The structural positions of melt may be related to the sites of initial fluid pathways rather than to later melt segregation. (3) Deformation may be induced by volume changes caused by melting during fluid infiltration. In summary,

meso- and microstructures in migmatites generated by water-assisted melting may be associated with diagnostic features differing from those of migmatites formed by dehydration melting. The distinction of structures related to volume changes from those caused by regional stress field will be a task for future work.