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Phase relations and dehydration behaviour of calcareous sediments at P-T conditions of accretionary wedge systems

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In a recent paper (Eur. J. Mineral. 20), Massonne and Willner (2008) presented P-T pseudosections for common rocks involved in accretionary wedge systems and argued that the dehydration of psammopelitic rocks could be an essential process for the formation of these systems. These authors assumed that this dehydration process leads to softening of the sedimentary cover of oceanic crust during early subduction so that this material can be scraped off the basic crust. Since many accretionary wedge systems contain metamorphosed calcareous sediments it was tested which influence carbonates, ignored by Massonne and Willner (2008), could have on the dehydration behaviour of these sediments. For this purpose, P-T pseudosections were calculated for a calcareous greywacke and a marly limestone in the system Na-Ca-K-Fe-Mn-Mg-Al-Si-Ti-C-O-H with the PERPLE_X software package (Connolly, 2005) for the pressure-temperature range 1-25 kbar and 150-450°C. In addition to the thermodynamic data and solid solution models already used by Massonne and Willner (2008), a newly created quaternary (Ca-Mn-Mg-Fe^{2+}) solid solution model was applied to carbonate with calcite structure together with an existing dolomite-ankerite model. Aragonite was considered as a pure phase. The Mn end-member was added to the previously used stilpnomelane model in order to calculate the P-T conditions of garnet formation at high pressure.

Along a low geotherm of 10-12°C/km, the dehydration behaviour of a calcareous greywacke resembles that of the previously studied psammopelite. However, the relevant dehydration event (release of about 1 wt% H_2O) occurs in the temperature interval 270-330°C and, thus, at temperatures about 30°C higher than in an ordinary psammopelite. The calculated compositions of fluids generated at low geotherms (<20°C/km) are close to pure water because CO_2 remains to be stored in carbonates. Considerable amounts of H_2O are also stored in minerals but at geotherms only below 7°C/km. The marly limestone behaves differently. At geotherms <10°C/km about 3 wt% of H_2O can be stored in minerals down to great depths. In fact, geotherms between 10-12°C/km result in a considerable release of H_2O but at relatively high temperatures around 450°C. Thus, a succession of marls and limestones at a continental margin can possibly be transported, compared to metapsammopelites, to greater depths in a collisional setting before being involved in an accretionary wedge system or even be subducted together with the underlying oceanic crust.