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Textural relations of quartz grains and diagenetic quartz cement in deeply buried sandstones, offshore Norway. A petrography and SEM EBSD study.

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Deeply buried quartz-rich sandstones commonly show extensive porosity loss due to diagenetic quartz overgrowths ascribed to chemical compaction by dissolution and cementation processes. The diagenetic growth of quartz cement has a great impact on reservoir quality of some of the important deep petroleum reservoirs offshore Norway, and the distribution and predictability of quartz cement occurrence in terms of temperature and kinetic parameters has been thoroughly investigated elsewhere. The mechanisms of deformation and cement growth in deep burial diagenesis have been less studied. In this study we have examined microstructural relations of detrital quartz and diagenetic quartz overgrowths by optical petrography, SEM electron backscatter, cathodoluminescence and electron backscatter diffraction (EBSD) analysis in relatively quartz rich, Mesozoic sandstones from 2.5-5km burial depths. The studied sandstones vary with respect to diagenesis and degree of quartz cementation and the following sample types have been investigated 1) extensively quartz cemented sandstone, 2) sandstone showing dense grain packing and limited quartz cement and 3) stylolite bearing sandstone. Petrographic studies suggest relatively early quartz cementation and relatively little compaction in terms of total volume loss in type 1 sandstones, and more extensive compaction in type 2 and 3 sandstones.

Quartz overgrowths (cement rims) occur in optical continuity with the detrital host grains, and are verified as syntaxial by the EBSD analysis. Overgrowths are also seen as extensions from subgrains of slightly different optical orientations, either suggesting inheritance of detrital grain deformation structures, or alternatively that subgrain forming deformation took place after burial. Low-angle boundaries are also visualised

by EBSD analysis.

The main result from the EBSD analysis is identification and mapping of frequent dauphiné twins not visible in the optical microscope. Dauphiné twins may form by various processes, including deformation, and an interesting question is if such twinning can be used as an indication of compaction induced deformation. Orientation maps show dauphiné twins present in all the studied samples, both in detrital grains and quartz overgrowths, and in some cases also crossing grain-cement boundaries. A general problem in sedimentary formations is to distinguish inherited from compaction-induced deformation structures. Syntaxial cement growth on pre-existing twin and deformation zones in detrital grains may explain some of the observed structures. However, the occurrence of dauphiné twins emanating from contact areas of detrital grains in compacted sandstone (type 2) and within quartz overgrowths in cemented sandstone (type 1) is evidence that deformation induced twins may also have formed in the diagenetic regime and post-date quartz cementation.