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Deformation of carbonates, experimental mechanical and chemical compaction

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Processes controlling compaction, i.e., porosity reduction, in carbonate sediments are still poorly understood. Mechanical compaction as a function of increasing effective stress during burial may be reproduced in laboratory since it is not strongly time dependent. Whereas chemical compaction, involving pressure solution, is much more complex. Better description and modelling of dissolution, diffusion and precipitation is needed. Two sets of experiments were realized in which the creep deformation of carbonate samples was measured in presence of reactive fluid. The aim is to provide strain laws for modelling carbonate sediments compaction as a function of stress, temperature and fluid chemistry.

One the one hand, well cemented dry carbonate rocks subjected to 50 MPa vertical effective stress showed only elastic deformation of less than 0.5 % and no creep. By contrast, water saturated samples of carbonate sand showed 0.8% creep strain after 60 hours at 30 MPa effective stress and 50 degree Celsius. This chemical compaction was sensitive to the fluid chemistry: increasing calcite solubility by adding NH_4Cl into the pore fluid enhanced deformation at constant stress. This is an indication that pressure solution played a major role.

On the other hand, pressure solution on a micro-scale was tested using single contact experiments on calcite monocrystals. The rate of dissolution and diffusion was measured as a function of the effective stress at grain contacts as small as few thousands of square micrometers. Dissolution was monitored through time using a camera, and the

interface’s roughness was characterized using white light interferometry microscopy.