Appendix for "P- and S-wave velocity measurements of water-rich sediments from the Nankai Trough, Japan" by Kai Schumann, Michael Stipp, Jan H. Behrmann, Dirk Klaeschen and Detlef Schulte-Kortnack

IODP whole round drill cores of 66 mm diameter were reduced to 50 mm diameter to fit into the deformation apparatus. Sample cylinders lengths were in the range between 48 and 102 mm, depending on the available sample material. The accuracy of the initial length measurements on the samples is ±1 mm, resulting in an error of 2%. After deformation samples were axially shortened up to 60%. Samples were jacketed into a 0.4 mm thick natural rubber sleeve to prevent fluid exchange between the sample and the surrounding cell water. Filter paper and sintered filter stone disks were placed at the sample ends to prevent particles being flushed out of the sample. A 1:1 mixture of boiled water and distilled water (~20°C) was used as confining pressure medium and pore fluid. The effect of smectite swelling due to the usage of distilled water can be neglected, since only small amounts of pore fluid needed to be added to the samples during the saturation phase. Hence, water loss during transport, storage and preparation of the samples was small, and it can be assumed that any salt largely remained in the samples [cf. *Kitajima et al.*, 2012] and the addition of the used water mixture does not decrease the salinity of the pore water. Furthermore, the smectite content in our samples is small ranging between 1.5 and 6.2% except for one core sample (316-C0007C-7X-1) with a larger content of 15.4% smectite (Rietveld refinement of synchroton radiation data; *Schumann et al.,* [in prep.]). Sample saturation was checked by conducting B-Tests in some samples [*DIN 18137 part 2*]. In this test, the ratio of pore pressure increase (Δu) versus confining pressure increase ($\Delta\sigma_3$) is indicative for the saturation (B) of the samples ($B= \Delta u/ \Delta\sigma_3$). According to DIN 18137 part 2, saturation is achieved for $0.9 \leq B \leq 1.0$. Only sample K018 had a much lower B-value of 0.81. Sample saturation was additionally verified by controlling the pore pressure equilibration and the burette reading during pressure increase under drained conditions.

During the experiments, we continuously measured time, axial displacement, cell or confining pressure (σ_3), axial load (σ_1), pore fluid pressure and the amount of pore fluid expelled out of the sample during stages of drained pressurization. The recording interval during the pressure increase and the pressure stepping tests was 5 seconds and during the displacement rate tests it was 5 seconds for displacement rates of 0.1 mm/min and faster and 1 second for rates slower than 0.1 mm/min. The triaxial deformation experiments are described in detail by *Stipp et al.* [subm.]; stress/strain and pore pressure/strain-diagrams are shown in the supplementary material 1 and 2. Additional plots of Vp, Vs and displacement versus time of samples K020 and K022 are given in supplementary material 3.

Each triaxial experiment can be subdivided into three experimental stages:

(1) Initial confining pressure increase and pore fluid saturation: The confining pressure was increased at 5 kPa/min. The axial load was always kept 5 to 10 kPa above confining pressure up to a value of 300 kPa. At 300 kPa confining pressure, pore fluid saturation of each sample was achieved by applying a back pressure with a ramp of 5 kPa/min. This experimental stage was carried out under drained conditions and was terminated when the pore pressure reached 280-282 kPa, i.e. the back pressure level which usually took several hours to one day. The initial pressure increase is not further considered in this study, since sample saturation during this stage is incomplete.

(2) Pressure increase to experimental conditions: Prior to the deformation stage, the confining pressure conditions had to be adjusted to the experimental conditions (increase of σ_1=σ_3 to 400 kPa, 650 kPa and 1000 kPa). Pressurization was carried out under drained conditions and the back pressure was kept constant at 280 kPa.

Hence these later stages of pressure increase were similar to the initial pressure increase apart from the saturated conditions.

(3) Triaxial deformation: After completion of confining pressure increase and pore pressure equilibration to the back pressure level (overnight), the triaxial deformation test was carried out under consolidated and undrained conditions (CU-test). Three different types of triaxial deformation tests were performed.

In single step compression tests the samples were deformed beyond yield point to axial strains up to 36%. Tests were carried out at σ_3 = 1000 kPa and constant displacement rates of 0.01 and 0.1 mm/min. In pressure stepping tests, as the second type of test, confining pressure was increased stepwise (to 400 kPa, 640 kPa, and 1000 kPa), while at each step a constant displacement rate test (displacement rate of 0.01 or 0.1 mm/min) was carried out. Based on the three different confining pressures Mohr Circle constructions can be made for each individual sample to determine cohesion and the internal friction angle of the samples. In the third type of tests, the rate stepping tests, σ_3 was kept constant at 1000 kPa, but the displacement rate was increased stepwise in the range between 0.01 and 9.0 mm/min. Experimental test conditions are summarized in Table 3 (main body). For further information on the triaxial deformation experiments see *Stipp et al.* [2013].