Regular Oral Presentation

Structural breakup and recovery in natural mud after steady pre-shearing

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Natural mud can exhibit a complex rheological behaviour and particularly a thixotropic response due to the presence of organic matter/biopolymer. Such biopolymers can be linked to the presence and development of flocculated structures. These structures are sensitive to the shearing level and history and are associated to multiple length scales. In this study, the extent and rate of structural recovery was examined in mud sediments by measuring the storage modulus as a function of time using small amplitude oscillatory tests, after the application of destructive steady shearing (Fig. 1a). This linear viscoelastic response of the mud suspensions was further investigated as a function of several parameters including shearing level, shearing time, measuring geometry (Couette and Vane), temperature, density, and oscillation frequency. Rates of structural build-up in mud sediments were estimated by fitting the experimental data with a stretched exponential function in order to analyse the effect of above mentioned factors on the recovery rate of the structure. The results showed that the recovery of structure after shearing was instantaneous, however, the extent of recovery was highly dependent on the studied parameters. The extent of recovery was highest for the samples with lowest organic matter content (Fig. 1b). The effect of shearing time on the extent and rate of structural recovery was almost negligible. Using vane geometry the extent of recovery was higher than the Couette geometry. The increase in storage modulus with time was larger in case of higher temperatures (Fig. 1c), which suggests the importance of inter-particle interactions. A structural parameter was defined based on the storage modulus before and after shearing, with the aim of linking this parameter with the rheological properties such as yield stress. Yield stresses showed a strong dependency on the structural parameter of the suspensions, however, this dependence became negligible when the structural parameter decreased below the value of 0.46. The samples used in this study were obtained from the Port of Hamburg (Germany).

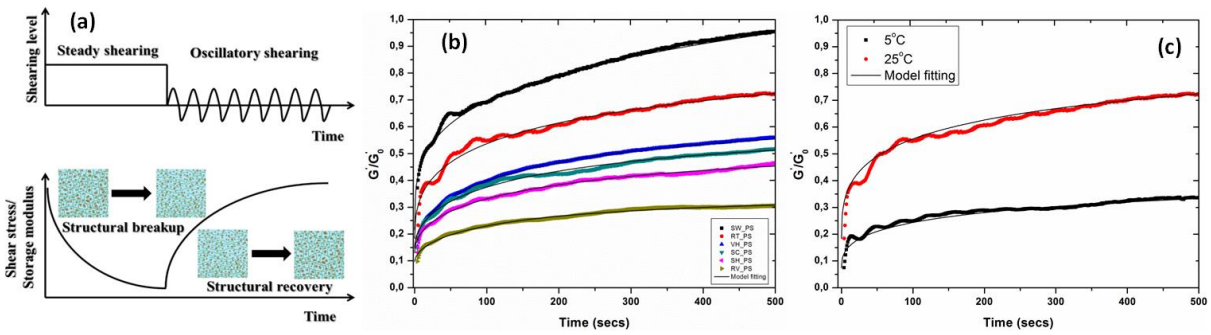

Figure 1: (a) Experimental protocol employed for the thixotropic studies (b) Development of normalized G' (G'_o is before shearing) for pre-consolidated sediments from different locations of Port of Hamburg (c) Development of normalized G' for different temperatures.