THE ACTION OF WATER FILMS AT Å-SCALES IN THE EARTH: IMPLICATIONS FOR MIDCRUSTAL EATHQUAKES AND OVERPRESSURING

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Water properties change with confinement within nanofilms trapped between natural charged clay particles. We investigated nanofilm characteristics utilizing sediments from deep drilling of the Nankai subduction zone at Site C0002 of the Integrated Ocean Drilling Program (IODP) through high-stress laboratory compression tests in combination with analyses of expelled pore fluids. We show that below 1-2 km, there should be widespread ultrafiltration of migrating fluids. Experiments to >~100 MPa normal compression collapses pores below a few ion monofilm thicknesses. A reduction towards a single condensing ion monofilm <10-20 Å occurs as stresses rise >100-200 MPa. Thus, porosity in high mineral surface area systems only consists of double and single monofilms at depths below a few km. It is not clear that thermal pressurization mechanisms and associate dynamic weakening mechanism operate effectively in monofilms. The resulting semipermeable properties also result in active flow causing variable segregation of ions and charged isotope species, increasing salinities in residual pore fluids at depth, and freshening of the fluids expelled during consolidation. Retardation of nanofilm collapse at ~17Å or ~2 x monolayer thickness below 2km at Nankai, however, indicates the onset of substantial geopressuring on the deeper "tremor" generating seismogenic fault. The properties of strange monofilm water, thus, have considerable implications for the deep hydrology of major Mw 8+ earthquake generating subduction zones. Indeed, the combined effects of advective flow, ultrafiltration, and diffusion and diagenesis could provide a unifying explanation for the origins of overpressuring and geochemical signals observed in many natural systems.