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Maximum seal capacity of sedimentary rocks as a framework concept for deep underground waste isolation

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We have developed a methodology to determine underground permeability structures and pore-pressure distribution from surface and/or core samples. Tertiary to Quaternary sedimentary basins were selected because their history both in space and time is much simpler than that of basement rocks and sedimentary rocks are still undergoing compaction and cementation. Our basic strategy has been three-fold: (1) measure transport properties under deep conditions to estimate those properties at depths, (2) measure transport properties for samples collected from all stratigraphic horizons to evaluate long-term cementation empirically, and (3) analyze interacting processes of sedimentation, fluid flow and compaction using measured properties to model the basin development. A good example of (2) is the result for Miyazaki Group whose porosity decreases with time; data there can be used to test prediction of the cementation via solution/precipitation processes in the future. A highlight result from our basis analysis is the prediction of the development of abnormal pore-pressure in the focal area of Chi-Chi earthquake which agrees nicely with drill hole data. Permeability decreases by a few orders of magnitude with increasing overburden pressure, and a good agreement cannot be obtained without taking this into account.

Another important problem is the effect of faults and fractures on fluid flow. Recent data on fault zone permeability, including ours on an active fault zone in Niigata basin, have been revealing that fault zones in porous sediments are more imperme-

able than host sediments. Also, our recent experimental data shows that that presence of fractures in porous sedimentary rocks has little effect on overall permeability when sediments are porous. Sedimentary rocks become more impermeable with increasing compaction and cementation, thus increasing seal capability. However, fluids can move easily along faults and fractures if sediments are cemented almost completely. Thus "***maximum seal capacity***" should exist in between where sediments are compacted enough to reduce permeability, but not enough for easy fluid flow along faults and fractures. Natural oil and gas must have made full use of these sediment properties in their accumulation. Determination of maximum seal capacity under various sedimentary environments will lead to further insight into material circulation in the Earth, CO_2 sequestration, waste isolation and other Earth's environmental issues.