Porosity Versus Depth Relationship Derived from Rock Mechanical Arguments

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During formation of sedimentary rocks, the porosity is gradually reduced as a result of the increasing weight of the overburden. Prior to diagenetic processes, the porosity at a given depth depends on the rock composition – which is defined during sedimentation, as well as stress and pore pressure and rock mechanical properties – which change gradually during the burial process. The relationship between porosity and depth in a sedimentary basin has been derived on the basis of simplified assumptions about stress-paths and rock compressibility, in combination with a published empirical relation between mean grain size and sea-floor porosity and a simple assumption relating mean grain size to clay content.

The porosity-depth relation is tested on a set of published data (Yang and Aplin, 2004: Petroleum Geoscience, 10, 153-162). They estimated several parameters, including porosity, pore pressure and clay content, from well logs for four different wells, making use of neural network methods. Our results show a good match between the theoretical relation and the log derived porosities, even when only two free parameters (related to rock mechanical properties) are used to fit the data for all four wells. The results indicate that the parameter relationships generated by the neural network to a large extent agree with the theoretically based relations derived here. This supports the validity of the physics used to derive these relations. The relations provide a foundation for practical estimation of pore pressures and the rock mechanical parameters involved.