Burial diagenesis of deep sea chalk as reflected in Biot’s coefficient

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Burial diagenesis of chalk has been widely studied, but little agreement has been reached on by which mechanism porosity declines, and on how to calculate the deforming stress in the most informative way. Data from Ocean Drilling Program show that calcareous ooze transforms to chalk and chalk to limestone as burial increases and porosity decreases. The porosity decrease is accompanied by an increasing velocity to elastic waves, and consequently a decreasing Biot’s coefficient, as estimated from velocity and density of core samples. When the effective burial stress is normalized to total horizontal cross sectional area, the porosity is found to decline as a function of stress. The porosity trend proceeds smoothly from ooze over chalk to limestone. By contrast, when vertical effective stress is normalized to grain contact area, each lithology shows a distinct porosity-decline - stress pattern. In the ooze, we find that the natural compaction causes an increasing stress on grain contact area, indicating that the ooze particles become strongly strained. In the chalk section, contact cement is probably the reason why particles become less strained as porosity declines. In the limestone, stress on particles apparently is low and not correlated with porosity, probably because the pore-filling cementation in this interval causes Biot’s coefficient to decline as burial increases. Limestone from the water zone of the North sea Chalk Group follows the same stress trend as deep sea limestone. These results indicate that by normalizing effective stress to grain contact area, we can get information about the mechanism behind burial related diagenetic porosity decline.

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