Chemical Compaction

Porosity reduction by means of quartz cementation, smectite-illite reactions, and other chemical compaction mechanisms.

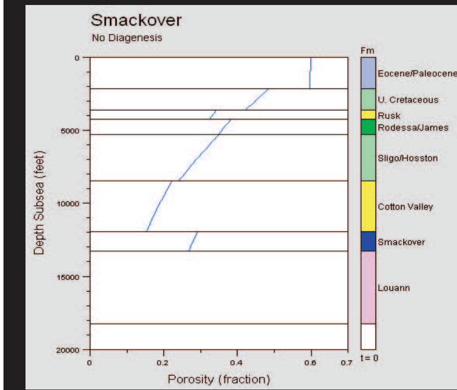
Quartz Cementation:
Walderhaug (1996) presented the basic theory that quartz cementation is one of the main porosity reduction mechanisms in quartzose sandstone. Dissolved silica, considered to be sourced from quartz dissolution at stylolites or individual quartz grain contacts containing clay or mica, diffuses short distances to sites of precipitation on clean quartz surfaces. Once quartz cementation starts, compactional porosity reduction is considered to be minor and porosity reduction within the modeled sandstone volume is considered to be equal to the volume of precipitated quartz cement. The BasinMod quartz cementation option is a modification of this theory.

Smectite-Illite:
Studies indicate that shale porosity reduction at temperatures greater than 60 C may be mainly due to diagenetic reactions (especially that of smectite to illite) rather than mechanical compaction processes (Walderhaug et al., in prep). The precipitation of illite and the collapse of pores are considered to be the principle processes contributing to diagenetic porosity loss. K feldspar, smectite, and kaolinite react to form illite and quartz, among other minerals.

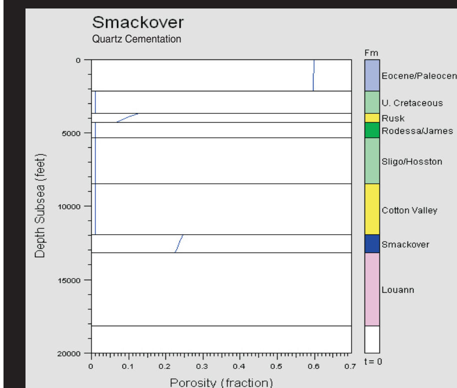
Generic Chemical Compaction:
The generic chemical compaction option in BasinMod allows the user to model multiple chemical compaction mechanisms such as opal-quartz transformation and illitization of kaolinite by customizing equations. The volumes of dissolved load-bearing reactant and precipitated product are considered to be exponential functions dependent on fraction of volume, concentration of limiting reactant, frequency constants, activation energy, and temperature.

Based on: Walderhaug, O., 1996. Kinetic Modeling of Quartz Cementation and Porosity Loss in Deeply Buried Sandstone Reservoirs: Amer. Assoc. of Petrol. Geol. Bull., vol. 80, no. 5 (May, 1996), pp. 731-745.

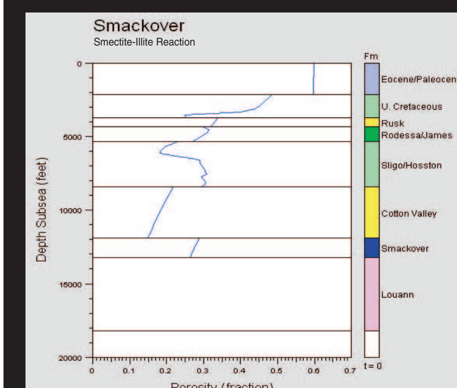
Walderhaug, Nadeau, and Bjorkum, in prep. A quantitative model of mineral diagenesis, porosity reduction, and permeability decrease in shales.



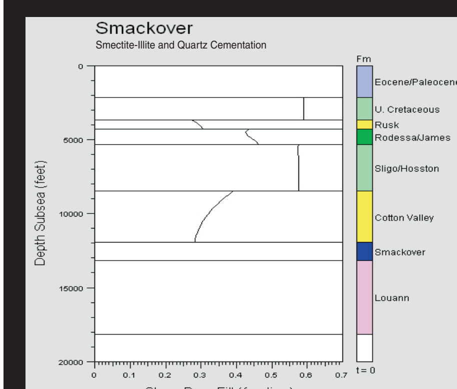
Porosity vs. Depth without Diagenetic effects.



Porosity vs. Depth showing Diagenetic effect of Quartz Cementation.



Porosity vs. Depth showing Diagenetic effect of Smectite-Illite reaction.



Chemical Pore Fill vs. Depth with Quartz Cementation and Smectite-Illite Compaction.

PRA

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