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America and a member of the A.A.P.G., the West Texas

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related to reservoir quality

The reservoir quality of sandstone is almost entirely controlled by diagenetic events. The chemical and physical properties responsible for diagenesis are complex and may influence sand during all stages of burial and, in some basins, during subsequent uplift. Petrographic studies by many workers in the past 10 years provide the basis for formulating rules of sandstone diagenesis that help in predicting reservoir quality in different formations. Most of the rules listed below are empirical, and instructive factors are still poorly understood. The list is also not complete.

1. The detrital mineral composition of a sand determines 10-50% of its diagenetic history. 2. Porosity lost by compaction cannot be regenerated during subsequent diagenetic events. Sands with abundant clay minerals of clay-10% diatoms, fossil pebbles, shale clasts, or clasts yield little primary porosity. Many secondary pores are produced by dissolution of carbonate cement and evaporite cement. 3. The loss of primary porosity through compactional deformation of clays and diatomaceous takes place during burial of 8,000 ft (2,450 m); loss of porosity by compaction at greater depths is by pressure solution of detrital grains. 4. Pressure solution of quartz grains is enhanced by the presence of grain coatings of illite and by a lesser degree by chlorite. 5. Quartz cements have a affinity for the coarser, more permeable sand in a formation. However, it rarely fills all pores in a sandstone except in some coarser granular sandstone or in quartz arenite. 6. Carbonate cement may have a patchy distribution in a bed, but fills all pores to produce a nonporous rock where it is present. 7. Carbonate cement is the dominant or only cement in sandstone with abundant carbonate fragments or carbonate rock fragments; the carbonates are derived from the sand. 8. Pettitecotic exhaline cement is the result of cementation that progressed from widely spaced nodule-like bodies. 9. Kaolinite forms by the replacement of feldspar and to a lesser degree of mica in sands with more than 10% volcanic rock fragments. 10. Chlorite should be expected as a diagenetic mineral in feldspar- rich sands (arkose and subarkose) and in sands with more than 10% volcanic rock fragments. 11. Chlorite and/or mixed-layer clay should be expected as a diagenetic mineral in sandstone with more than 10% volcanic rock fragments. 12. Chlorite and mixed-layer clay, because of their tendency to bridge pores and produce baffles in pores, can seriously reduce permeability. 13. Early-formed illite, typically present as grain coatings, does not seriously reduce permeability; late-formed illite tends to bridge pores and produce baffles and seriously reduce permeability. 14. Mica cement is formed in continental sands above the water table. 15. Opal cement is formed in continental sands above the water table in continental sections where volcanic ash beds are intercalated with sands. 16. Some degree of secondary porosity is to be expected in a sandstone. However, there are few clues at present to predict the degree of secondary porosity or the cleanliness of secondary pores produced. Many secondary pores are micro- pores within incompletely dissolved feldspar or rock fragments. The best secondary pores are produced by dissolution of carbonate cement and evaporite cement. 17. Secondary porosity develops chiefly at depths greater than 8,000 ft (2,450 m) in the Gulf Coast, but can persist to depths of 20,000 ft (6,100 m). After their generation, secondary pores undergo some destruction during subsequent deeper burial by infilling with late-diagenetic ferroan carbonate and/or kaolinite. 18. Sands that had the greatest permeability at the time of deposition will develop the best secondary porosity. The best permeability will be in the coarsest, well-sorted sands (except in quartzarenite, where the coarsest beds may undergo complete cementation by quartz).